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UNITED STATES DEPARTMENT OF THE INTERIOR, STEWART L. UDALL, SECRETARY  
Frank P. Briggs, Assistant Secretary for Fish and Wildlife  
Fish and Wildlife Service, Clarence F. Pautzke, Commissioner  
Bureau of Sport Fisheries and Wildlife, Daniel H. Janzen, Director

WATERFOWL UTILIZATION AND HUNTING KILL  
1946 THROUGH 1960

Upper Mississippi River Wildlife and Fish Refuge  
and  
Mark Twain National Wildlife Refuge

by  
William E. Green  
Wildlife Biologist



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## ABSTRACT

A 15-year study was made of hunter utilization of waterfowl on the Upper Mississippi River, and of the effects of management practices, open and closed areas, seasons, and bag limits on waterfowl harvest.

This survey covers 251,876 hunter trips, on which 283,763 ducks were taken for a daily average harvest of 1.12 ducks per day of hunting. It is estimated that in an annual average of 135,790 days of waterfowl hunting on the area, hunters bagged 165,190 ducks while losing 38,625 cripples, for an estimated average total annual kill of 203,800 ducks.

A description of hunting conditions, public hunting areas, and closed areas is given, together with hunting pressures since 1953, species composition of the bag, and comparative hunter success on hourly, daily, and annual bases.

Crippling losses have been assessed and related to other hunting factors such as ease of killing ducks, cover, and type of hunting. A table of comparative vulnerability for waterfowl harvested in the area compares other species with mallards.

Apparently, presunrise hunting is twice as effective per unit of time as is hunting at other times of the day; crippling losses are higher per unit of time, but the rate of crippling is actually less.

Distribution of kill among hunters indicates that only 10.44% of the hunters checked succeeded in taking over three ducks per day, while over 45% failed to bag game on the day they were checked. The 10.44% of the hunters taking over three ducks accounted for 37.20% of the total harvest, although the harvest was only 9.54% higher than had the limit never exceeded three ducks per day.

Data also show how changing opening dates will have a bearing on the harvest of certain species. Delaying the opening as little as 1 week later than October 1 will greatly reduce the harvest of such species as blue-winged teal and wood ducks.

## INTRODUCTION

The Upper Mississippi River Wildlife and Fish Refuge, with headquarters at Winona, Minn., was established by an act of Congress on June 7, 1924. This act authorized acquisition of 284 miles of bottomlands along the Mississippi River from the Chippewa River in Wisconsin to Rock Island, Ill. At the present time, the Refuge (administered by the Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior) is managing 194,000 acres of land within the limits defined by the act. This includes lands acquired in fee by the Bureau of Sport Fisheries and Wildlife, as well as lands made available by transfer from the Corps of Engineers, U. S. Army, under cooperative agreement.

In the early 1940's, the Bureau began negotiations with the Corps of Engineers for the right to administer the wildlife resources on lands acquired by the Corps between Rock Island and Alton, Ill. The Calhoun Unit, in 1942, was the first unit in this reach of the river to be placed under Bureau management. As additional lands between Rock Island and Alton came under Bureau management, they were also administered as a part of the Upper Mississippi Refuge. Ultimately, about 67,695 acres of land along that portion of the Mississippi River were made available for such purposes. When the last units were added as the result of a cooperative agreement in 1954, the Upper Mississippi Refuge was administering lands along 561 miles of the Mississippi River, roughly between Wabasha, Minn., and Alton, Ill.

In August 1958, the reach of the river between Rock Island and Alton, Ill., was officially separated from the Upper Mississippi Refuge. This area was designated as the Mark Twain National Wildlife Refuge, with headquarters at Quincy, Ill.

Within the combined refuges, 261,695 acres of land are devoted to waterfowl management. These include 194,000 acres on the Upper Mississippi Refuge and 67,695 acres on Mark Twain Refuge and lands licensed to the States between Rock Island and Alton, Ill. Over the entire area, there are 205,292 acres (78.45%) open to public hunting and 56,403 acres (21.55%) in sanctuary areas closed to hunting.

Open and closed areas on the Upper Mississippi Refuge are distributed among the States of Minnesota, Wisconsin, Iowa, and Illinois as follows:

<u>State</u>	<u>Open to hunting</u>	<u>Closed to hunting</u>	<u>Total</u>
<u>Acres</u>	<u>Percent</u>	<u>Acres</u>	<u>Percent</u>
Minnesota....	28,243	85.6	4,740
Wisconsin....	64,662	74.5	22,140
Iowa.....	40,446	79.6	10,345
Illinois....	<u>19,874</u>	<u>84.9</u>	<u>3,550</u>
Total.....	153,225	79.0	40,775
			21.0
			194,000

Table 1 shows a summary of lands open to hunting, closed to hunting, and whether under State or Federal control.

In the fall of 1946, in connection with activities of the Technical Game Committee of the Upper Mississippi River Conservation Committee, bag checks were initiated on the Upper Mississippi Refuge and the Calhoun Unit. Bag checks have continued without interruption on these areas since that time. As additional units came under Bureau administration, the surveys were extended to include them. Bag-check information has proven invaluable to the Upper Mississippi and Mark Twain Refuges in the proper evaluation of the effectiveness of the "Closed Areas" and has enabled the refuges to compare previous and current closed areas along the river with respect both to waterfowl use and to the effect on the hunting public. We now have bag check survey data from the refuges as follows:

Upper Mississippi Refuge      15 years

Mark Twain Refuge:

Gardner Unit	4 years *
Keithsburg Unit	7 years
Louisa Unit	13 years
Batchtown Unit	14 years
Calhoun Unit	15 years

\*Gardner Unit was established in 1958. In 1957, bag-check data were gathered from Quincy Bay, just south of the Gardner Unit, by the State of Illinois. Data from Gardner Unit and Quincy Bay are now combined, since they cover the same general area.

Table 1 - Acreage Under Management

	<u>Acres Open</u>	<u>%</u>	<u>Acres Closed</u>	<u>%</u>	<u>Total</u>
UPPER MISSISSIPPI REFUGE	153,225	78.98	40,775	21.02	194,000
<hr/>					
MARK TWAIN REFUGE					
Louisa Unit	-	-	3,110	100.00	
Keithsburg Unit	-	-	1,396	100.00	
Gardner Unit	-	-	1,488	100.00	
Batchtown Unit	-	-	1,995	100.00	
Calhoun Unit	-	-	4,353	100.00	
Public Hunting *	7,414	100.00	-	-	
<b>Total:</b>	<b>7,414</b>	<b>37.53</b>	<b>12,342</b>	<b>62.47</b>	<b>19,756</b>
<hr/>					
<b>TOTAL FEDERAL MANAGEMENT</b>	<b>160,639</b>	<b>75.15</b>	<b>53,117</b>	<b>24.85</b>	<b>213,756</b>
<hr/>					
STATE MANAGEMENT					
Iowa	6,656	100.00	-	-	6,656
Illinois	27,423	94.84	1,492	5.16	28,915
Missouri	10,574	85.50	1,794	14.50	12,368
<b>Total:</b>	<b>44,653</b>	<b>93.15</b>	<b>3,286</b>	<b>6.85</b>	<b>47,939</b>
<hr/>					
<b>GRAND TOTAL:</b>	<b>205,292</b>	<b>78.45</b>	<b>56,403</b>	<b>21.55</b>	<b>261,695</b>

\*This area involves 7,414 acres of lands originally made available to the State of Iowa for management in Pools 17 and 18. The State decided not to manage this portion, and returned it to the Bureau. It is now administered as a part of the Louisa Unit of Mark Twain Refuge.

## DESCRIPTION OF THE AREA

Except for pools 1, 2, and 3 and the recently constructed "Chain-of-Rocks" Dam near St. Louis, Mo., all of the locks and dams constructed by the Corps of Engineers in connection with the 9-foot navigation channel project on the Upper Mississippi River are located in the area under study. Thirteen of the dams are on the Upper Mississippi Refuge, and 10 are on Mark Twain Refuge.

At the time the Upper Mississippi Refuge was established, the river bottoms included a large number of wooded islands, with deep, intervening sloughs the rule. Hundreds of lakes and ponds were scattered through the wooded areas. There were some hay meadows on the islands, together with small farming operations, but the bottoms were essentially wooded. The marshes were confined to the shores of lakes and guts leading off the sloughs. Marsh flora was also limited and the marshes tended to dry up before the end of summer. Many lakes and ponds annually dried up completely, while water levels in others receded markedly.

Constant drying out of marshes and ponds resulted in considerable loss of marsh and aquatic species, especially the annual plants. Consequently, waterfowl habitat was quite limited.

In the early 1930's, the Corps of Engineers initiated the 9-foot channel project, which ultimately resulted in the present series of 26 locks and dams. These impoundments abruptly changed the river bottoms from an area of wide fluctuation in water levels to an area of semistabilized water. While spring floods still occur, the bottoms do not dry out in the summer. Lack of marsh and aquatic plants is no longer a problem, especially north of the Wisconsin River. Old hay meadows and timbered areas are now permanent marshes providing excellent habitat for waterfowl.

There is considerable variation in habitat over the 561 miles of the Upper Mississippi and Mark Twain Refuges. The best marsh habitat is found north of the mouth of the Wisconsin River on the Upper Mississippi Refuge. Below the Wisconsin River, few extensive marshes have developed to date.

Above the mouth of the Wisconsin River, physical features necessitated construction of a series of comparatively short navigation pools. Seven pools are located in the upper 50 miles of the Refuge. In these short pools the ecological picture has changed to a marked extent. From pool 7 south, much longer pools (averaging 30 or more miles in length) are found. Here the natural ecology has not undergone such a marked change.

Three distinct zones are found in each of the navigation pools. The upper end remains essentially in a normal open-river condition. Here original, natural water levels have not been altered to any great extent, marsh development is limited, and the natural condition of deep sloughs and wooded islands is prevalent. In the middle zone of each pool, the dams have backed water over islands and old hay meadows, spreading water out over large, comparatively shallow areas. It is in this portion that the best marsh development has occurred. In the lower ends of the pool, immediately above each dam, water is impounded to a depth which often precludes marsh development. While this portion is essentially deep water, good aquatic plant growth has occurred in many instances, although true marsh development is limited.

Prior to impoundment by the dams, timber was cleared to a contour 3 feet above the expected normal pool level. In all the pools most of the timber was cleared. Clearing and subsequent flooding made wide areas of former timberland available for marsh development and aquatic growth.

Following impoundment in what is now the Upper Mississippi Refuge, important aquatic plant beds developed, and at present vast quantities of valuable waterfowl food and cover plants occur. So diversified are the aquatics that it is not unusual to find more than two dozen species in a matter of minutes anywhere in the better marshes.

Excellent growths of bulrush, burreed, sagittaria, and wildrice abound, with the rice increasing each year that water levels are favorable. Wildrice is of great importance not only as food and cover for ducks, but also as concealment for hunters. Twelve species of pondweeds form the bulk of the valuable waterfowl food on the Upper Mississippi Refuge. Wildcelery is increasing annually and is now locally abundant over much of the area.

Comparatively little field feeding occurs on the Upper Mississippi Refuge north of the Wisconsin River, perhaps because there is sufficient natural food produced in the marshes to support the waterfowl populations using the area. South of the Wisconsin River, field feeding does occur, become more and more important progressively down river. This could be due part to the arrival of ducks from the northwest where they have been accustomed to field feeding as well as to the decrease in natural aquatic foods.

As a matter of general interest, it should be pointed out that except for pool 13 where there is some scull-boat hunting, most hunting on the Upper Mississippi Refuge is normally

associated with marshes and mostly from blinds, with little open-water, point, or pass shooting.

On Mark Twain Refuge field feeding is the rule, either on refuge lands or in agricultural fields away from the refuge. Again, it is surmised that this is due to ducks moving in from a northwesterly direction from the prairies, where they have experienced field feeding to a large extent.

The Bureau has little control over water-level management except for a few, small, diked-off areas on the Upper Mississippi Refuge, and on Louisa and Keithsburg Units of Mark Twain Refuge. The Batchtown and Calhoun Units are both backwater areas resulting from impoundment in connection with the 9-foot navigation channel project. The Gardner Unit is a huge island in the Mississippi River, a large portion of which has been farmed for many years. Elsewhere, the Corps of Engineers controls water levels primarily in the interest of navigation. So far as possible, the Corps manages water levels during the fall with both waterfowl use and hunting opportunity in mind.

#### TECHNIQUES

##### Waterfowl populations

The Upper Mississippi Refuge is divided into administrative districts, each covering a different segment of the river and averaging about 30 miles in length. A resident manager is assigned to each district. It is his responsibility to conduct inventories and bag checks and to determine hunter activity in his own district. Each week a ground census is conducted by the district managers, and the data are submitted to the Winona office where they are compiled to determine the total refuge population. This system of obtaining population data has been in use for the entire period of this study, and it has enabled headquarters to keep quite accurate records on waterfowl movements and populations. Since 1955, in addition to the ground surveys, biweekly aerial surveys have been conducted each fall. Reconciliation is made between the air and ground data.

Resident managers have also been assigned to each unit of Mark Twain Refuge, and they too have conducted surveys and reported weekly populations and movements. In addition to these ground counts, we also receive reports from Frank Bellrose of the Illinois Natural History Survey who conducts periodic aerial surveys which include the Mark Twain Units.

### Bag check surveys

Bag-check information on the Upper Mississippi Refuge has been obtained by staff member field contacts with hunters throughout the refuge. The checks are made at access points, where hunters concentrate, and in the field as well. These contacts were distributed throughout the refuge and throughout the season, to provide as representative a sample as possible. For purposes of comparison, the same areas have been checked each year.

In the early work on Mark Twain Refuge, information was obtained by spot checks of hunters at access points or in the field, in a manner similar to that used on the Upper Mississippi. The same system is still used at the Keithsburg Unit. However, the State of Illinois now operates check stations at Quincy Bay south of the Gardner Unit and near the Batchtown and Calhoun Units, and the State of Iowa operates a check station near the Louisa Unit. Since the State checking stations were established, much of the bag-check information on these areas has come from these stations. The States of Illinois and Iowa have been very cooperative in making these data available. Throughout the Mark Twain Refuge, the staff continues to conduct spot checks of hunters to provide information from areas which are not covered by the State checking stations. We believe that reasonably good sampling results.

Table 2 indicates the coverage obtained on the various units under study. The sampling percentage is derived by dividing the number of hunters checked into the estimated total days of hunting in each area. Although the data for the Upper Mississippi Refuge indicate a sample of only 5.77% of the hunters using the refuge, it must be remembered that there are about three times as many days of hunting done there as on Mark Twain.

### Crippling loss data

Crippling loss data were obtained by questioning most hunters contacted in connection with bag check surveys. Therefore, these data represent voluntarily reported crippling losses and are generally believed to be minimum.

Crippling-loss percentages were derived by adding reported cripples to checked kill to give the total kill, and then the crippling loss was calculated as a percentage of the total kill. Thus, if the average bag per day amounted to 1.10 ducks and the average crippling loss to 0.25 ducks per day, the total average kill per day was determined to be 1.35 ducks. Crippling loss was then determined by dividing 1.35 into 0.25 and converting the result to a percentage (18.5%).

Table 2 - PERCENT OF HUNTERS SAMPLED

Year	Upper Miss:: Louisa		Keithsburg		Gardner		Batchtown		Calhoun		MARK TWAIN::		ENTIRE:	
	Refuge	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Refuge	Area			
1953	4.17	14.56	11.43	-	32.75	24.74	26.27	10.44						
1954	5.22	15.66	13.25	-	27.84	13.09	17.81	8.55						
1955	5.64	6.87	.86	-	60.10	43.90	39.68	15.53						
1956	5.12	26.79	5.80	-	61.54	62.09	59.24	17.97						
1957	4.43	21.74	-	96.17	60.28	84.64	74.15	20.36						
1958	6.66	29.07	-	93.43	67.20	70.39	73.46	20.70						
1959	8.75	9.75	31.40	88.55	85.98	51.14	66.20	25.94						
1960	9.17	75.79	96.57	100.00	93.89	87.60	87.97	36.56						
AVERAGE	5.77	29.69	9.91	95.66	57.60	48.27	52.45	18.12						
TOTAL HUNTERS	823,390	39,920	8,065	13,497	84,550	150,340	296,372	1,119,762						

### Hourly-success data

Again, these data were obtained from voluntary reports of hunters checked as to how long they were afield on the day they were checked.

### Hunting pressure

Each week during the hunting season the district managers on the Upper Mississippi Refuge report the total man-days of hunting in the districts. These reports are based on car counts, concentrations of hunters, number of hunters contacted in the field, etc. District reports are combined into an overall refuge report. Since these data are collected the same way every year, there is a good basis for comparing hunting pressure from year to year.

On Mark Twain Refuge hunter-use data are obtained by individual units and are based on car counts, hunter contacts, and records of hunters passing through the check stations operated by Illinois and Iowa.

### Estimation of total kill

Estimated total kill is calculated as follows: For each district on the Upper Mississippi Refuge, the average daily bag for the season and the average daily crippling loss is based on the sample of the hunters actually checked. These average figures are expanded to derive the estimated total kill. Thus, if the average daily kill is determined to be 1.30 ducks and the total hunting pressure estimated at 20,000 man-days, it is assumed that all 20,000 hunters succeeded in taking the average harvest, and an estimated bag of 26,000 ducks is calculated. If the average crippling loss is 0.25 ducks per hunter per day, this figure is similarly expanded to show a crippling loss of 5,000 ducks. The two figures are then combined to indicate an estimated total kill of 31,000 ducks for the district. After these data are worked up for each district, the district totals are added to arrive at the refuge total.

On Mark Twain Refuge a similar system is used, expanding the seasonal average of daily kill and crippling loss from each Unit by multiplying the seasonal averages by estimated total days of hunting. Data from each Unit are combined to give the total refuge figure.

Where kill data are shown for the entire area, they are a composite of information from both the Upper Mississippi and Mark Twain Refuges, each of which was separately computed as described above.

## SUMMARY OF SEASONS AND MIGRATIONS

### Waterfowl timetables

Normally, by the time the hunting season opens on the Upper Mississippi Refuge, most species of ducks which use the area are already present, although not always in large numbers. By mid-August, populations start to build up, with blue-winged teal, American widgeon, and wood ducks being the first to start moving. By the end of the first week in October, the first cold snap of the fall has usually already occurred, and most of the blue-wings and a large part of the wood ducks have moved out of the upper portions of the Upper Mississippi Refuge. By mid-October, these two species are normally gone from the upper half of the refuge.

In 1953 the Branch of Refuges adopted the system of recording waterfowl use in terms of duck-days use, a figure derived by multiplying the average weekly populations by 7. This gives some measure of the overall use of an area, and provides a better basis for making comparisons from year to year.

Table 3 indicates an effort to convert previous waterfowl use data to duck-day use so that for the entire period of this study some comparison might be available. In this table, duck-day use before the fall of 1953 has been computed from data available in the files, while from 1953 through 1960 the weekly census figures were regularly converted to duck-day use.

Table 3 - Comparative Duck Day Use (Upper Mississippi Refuge)

<u>Computed from old data</u>		<u>Compiled under new system</u>	
<u>Year</u>	<u>Duck days use</u>	<u>Year</u>	<u>Duck days use</u>
1946	13,651,880	1953	8,842,540
1947	10,238,910	1954	9,235,149
1948	12,286,700	1955	10,560,949
1949	14,744,050	1956	11,489,961
1950	15,333,820	1957	14,298,774
1951	7,666,910	1958	12,851,426
1952	6,900,220	1959	8,538,215
		1960	11,215,645

As shown in tables 5 through 8, there has been a wide spread in the time of peak population build-ups in the area under study. On the Upper Mississippi Refuge, the earliest peak recorded occurred during the week ending October 11, 1958, while the latest peak occurred during the week ending November 28, 1953. On the average, the peak of the flight normally takes place about the first week in November.

As one progresses down river, peak dates are delayed approximately 1 week for each unit of Mark Twain Refuge. For example, Louisa Unit recorded its earliest peak during the week ending November 2, its latest during the week ending December 7, and averaged about the week ending November 23. Calhoun Unit (the southernmost, located at the mouth of the Illinois River, and about 250 miles south of the Upper Mississippi Refuge) had its earliest peak during the week ending November 30, the latest during the week ending December 28, and averaged the week ending December 7.

The earliest opening day during the period of this study was October 1. By referring to table 4, it will be noted that by opening day there have been fair populations of ducks present on most refuge areas, except at Louisa, Keithsburg, and Gardner Units of Mark Twain.

Table 4 - Opening Day Populations

<u>Refuge</u>	<u>Minimum Opening Day Count</u>	<u>Maximum Opening Day Count</u>	<u>Average Opening Day Count</u>
Upper Mississippi	56,092 (10/1/53)	136,455 (10/1/58)	94,295
Louisa	225 (10/6/56)	16,862 (10/20/59)	3,980
Keithsburg	100 (10/19/57)	1,281 (10/28/60)	710
Gardner *	125 (10/18/58)	2,322 (10/30/59)	1,540
Batchtown	500 (10/22/54)	156,450 (10/28/60)	31,150
Calhoun	13,350 (10/15/55)	35,000 (10/13/56)	27,305

\* Only 3 years' data

Tables 5 through 9 show a comparison of peak dates, peak numbers, and average peak populations for the area under consideration.

#### Duck-day use

The two refuges support heavy duck-day use. Tables 10 through 14 indicate that an average of 38,025,391 days of duck use occurs each fall. The Upper Mississippi Refuge has an average of 10,879,065 days' use; while the units of Mark Twain Refuge have a combined average of 27,146,326 days' use. Much of the use on Mark Twain occurs late in the fall, but with delayed hunting seasons there is still heavy use during the open season. On the Upper Mississippi Refuge it was found that over 84% of all fall duck use occurred during the period of the open hunting season, while for the entire area nearly 82% of all fall use occurred during the open season. Furthermore, the average weekly duck population occurring

Table 5 - COMPARISON OF PEAK DATES AND PEAK NUMBERS

1953 thru 1960 Fall Seasons

	:Upper Miss.: Refuge	Louisa Unit	: Keithsburg : Unit	Gardner Unit	: Batchtown : Unit	Calhoun Unit	E N T I R E : A R E A
<u>Peak Dates</u>	:	:	:	:	:	:	:
Earliest	: Oct. 12	: Nov. 2	: Nov. 9	: Nov. 16	: Oct. 26	: Nov. 30	: Oct. 26
Latest	: Oct. 30	: Dec. 14	: Dec. 14	: Nov. 30	: Dec. 28	: Dec. 28	:
Average	: Nov. 2	: Nov. 16	: Nov. 30	: Nov. 30	: Nov. 9-16	: Dec. 7	: Dec. 7
<u>Peak Numbers</u>	:	:	:	:	:	:	:
Lowest	: 160,845	: 45,672	: 2,170	: 7,611	: 42,300	: 203,200	: 406,172
Highest	: 345,280	: 251,150	: 135,150	: 35,454	: 1,001,800	: 714,800	: 1,379,965
Average	: 240,720	: 135,810	: 78,280	: 22,665	: 218,550	: 442,600	: 767,140

(Dates shown are last day of the week.)

Note: Peak numbers in the "Entire Area" column represent populations present over the 550 miles of the Mississippi River ON THE SAME WEEK; and are not necessarily the combined totals of the individual areas, each of which may have peaked at a different time, either earlier or later.

Note there is a difference of only one week in the average peak date on the Upper Mississippi Refuge and the Batchtown Unit of Mark Twain Refuge, although these areas are 250 miles apart. There are two reasons for this. First, Batchtown picks up ducks moving in from the northwest, and reaching the Mississippi River south of the Upper Mississippi Refuge. Batchtown also often has an earlier build-up than Calhoun Unit, which is only a few miles away on the Illinois River. There is some interchange of birds between these units in the fall. Batchtown is mostly quiet backwater which freezes with the first cold snap, at which time ducks move east across the ridge of Calhoun County to the Calhoun Unit, which remains open longer.

Table 6 - SUMMARY OF PEAK WATERFOWL NUMBERS

1953 thru 1960 Fall Periods

Year	8 years	7 years	7 years	3 years	8 years	8 years	8 years
	Upper Miss.	Louisa	Keithsburg	Gardner	Batchtown	Calhoun	ENTIRE
	Refuge	Unit	Unit	Unit	Unit	Unit	AREA
1953	206,520	-	-	-	1,001,800	302,000	1,379,965
1954	160,845	76,200	95,000	-	162,400	614,100	837,070
1955	304,579	152,200	95,000	-	82,200	714,800	849,975
1956	266,665	200,600	135,150	-	158,300	531,100	978,215
1957	345,280	251,150	80,000	-	56,900	407,500	640,505
1958	205,010	176,263	2,170 *	7,611	42,200	515,100	585,276
1959	203,957	98,613	40,225	10,968	88,200	253,100	405,172
1960	232,916	45,672	100,425	35,454	156,450	203,200	459,934
AVERAGE PEAK :	:	:	:	:	:	:	:
POPULATION :	240,720	135,810	78,280	18,010	218,550	442,610	767,140
Average With-:							
out 1953 Data:	245,600	135,810	78,280	18,010	106,665	462,700	679,600

\* Levees broken. No water.

Note: Peak numbers in "Entire Area" column represent numbers present over the 550 miles of river ON THE SAME WEEK; and are not necessarily the combined total of the individual Units, each of which may have peaked at a different time, either earlier or later.

In 1953, stream flow in Pool 25 (Batchtown Pool) was such that the dam was in "open gate" operation most of the summer, which did not impound water. This resulted in extensive mud flats throughout Batchtown Refuge. These flats produced tremendous beds of smartweeds and millet, resulting in extremely favorable conditions for pintails and mallards. This tended to concentrate ducks that would normally have been scattered in other areas, resulting in a peak of over 1 million ducks on an area only 1,995 acres in size. This unusual situation has not since been repeated, so it is probably best to drop this concentration from average data. (This has been done for this table ONLY.)

Table 7 - WEEKLY DUCK POPULATIONS AND PEAK NUMBERS

Upper Mississippi River Wildlife and Fish Refuge

September-December

WEEK ENDING	:	1953	:	1954	:	1955	:	1956	:	1957	:	1958	:	1959	:	1960	:
1	Sept. 7:	36,446	:	18,012	:	42,893	:	20,720	:	51,605	:	41,353	:	36,501	:	52,915	:
2	Sept. 14:	37,364	:	26,637	:	55,193	:	40,835	:	62,408	:	45,922	:	51,222	:	64,832	:
3	Sept. 21:	44,873	:	36,218	:	65,876	:	50,280	:	92,184	:	81,027	:	70,925	:	79,550	:
4	Sept. 28:	48,318	:	43,164	:	74,460	:	67,825	:	82,869	:	105,237	:	77,523	:	104,055	:
5	Oct. 5 :	56,092	:	58,432	:	92,035	:	77,413	:	113,952	:	136,455	:	69,438	:	127,330	:
6	Oct. 12:	50,384	:	75,594	:	116,950	:	64,325	:	93,040	:	205,010*	:	96,595	:	178,650	:
7	Oct. 19:	57,058	:	125,992	:	129,580	:	62,240	:	118,520	:	149,875	:	174,542	:	178,142	:
8	Oct. 26:	65,675	:	114,400	:	133,340	:	78,355	:	212,040	:	187,580	:	148,903	:	232,916*	:
9	Nov. 2 :	59,960	:	106,642	:	304,579*	:	135,605	:	345,280*	:	195,895	:	203,957*	:	179,005	:
10	Nov. 9 :	100,585	:	160,845*	:	242,422	:	196,365	:	274,880	:	194,435	:	147,516	:	112,439	:
11	Nov. 16:	121,884	:	153,680	:	120,315	:	259,621	:	238,855	:	151,111	:	78,120	:	71,217	:
12	Nov. 23:	202,365	:	129,976	:	76,125	:	266,665*	:	206,775	:	139,890	:	13,580	:	72,093	:
13	Nov. 30:	206,520*	:	123,375	:	39,575	:	114,005	:	85,735	:	112,435	:	14,438	:	31,744	:
14	Dec. 7 :	87,765	:	98,350	:	6,030	:	102,625	:	39,375	:	56,486	:	10,590	:	44,403	:
15	Dec. 14:	63,810	:	26,770	:	3,588	:	84,680	:	12,794	:	11,519	:	9,364	:	35,690	:
16	Dec. 21:	21,695	:	11,165	:	2,796	:	17,404	:	5,035	:	9,278	:	8,112	:	18,860	:
17	Dec. 28:	1,447	:	6,155	:	2,950	:	2,460	:	7,335	:	7,351	:	7,015	:	18,394	:
18	Jan. 4 :	979	:	3,902	:	-	:	-	:	-	:	5,059	:	1,404	:	-	:
<b>TOTAL DAYS :</b>			:		:		:		:		:		:		:		:
<b>USE</b>		<b>:8,842,540</b>	<b>:</b>	<b>9,235,163</b>	<b>:</b>	<b>10,560,949</b>	<b>:</b>	<b>11,489,961</b>	<b>:</b>	<b>14,298,774</b>	<b>:</b>	<b>12,851,426</b>	<b>:</b>	<b>8,538,215</b>	<b>:</b>	<b>11,215,645</b>	<b>:</b>

\*Peak concentration

Note: Earliest peak occurred the week ending October 12 in 1958; latest peak occurred the week ending November 30 in 1953; while average peak occurs during the first week in November.

Table 8 - WEEKLY DUCK POPULATIONS AND PEAK NUMBERS

Combined Units of the  
MARK TWAIN NATIONAL WILDLIFE REFUGE

September-December

WEEK ENDING	1953	1954	1955	1956	1957	1958	1959	1960
1 Sept. 7 :	3,450	14,050	12,205	8,980	2,575	10,015	14,185	6,930
2 Sept. 14 :	4,150	18,060	17,660	12,045	4,150	13,115	15,869	7,906
3 Sept. 21 :	8,500	11,930	23,970	18,930	7,300	16,205	30,898	7,905
4 Sept. 28 :	16,405	15,430	24,825	33,500	8,800	24,725	15,989	12,408
5 Oct. 5 :	28,500	20,050	27,500	39,325	7,750	36,710	18,960	35,728
6 Oct. 12 :	61,000	30,345	20,600	43,850	9,000	40,133	28,313	45,001
7 Oct. 19 :	70,200	49,800	36,100	50,450	31,825	44,966	62,640	95,898
8 Oct. 26 :	46,900	28,975	103,950	55,100	167,700	21,768	62,765	227,018
9 Nov. 2 :	79,600	57,000	445,700	89,550	218,800	33,023	197,182	91,769
10 Nov. 9 :	69,100	285,650	435,650	255,250	307,370	90,350	235,083	139,157
11 Nov. 16 :	350,300	246,115	446,200	386,950	401,650	60,450	225,816	101,899
12 Nov. 23 :	1,177,600*	340,700	463,450	711,550	322,425	81,690	149,395	101,094
13 Nov. 30 :	752,700	379,475	810,400*	719,300	297,200	160,153	181,265	261,831
14 Dec. 7 :	806,300	500,300	478,700	709,850	365,450	459,374	388,680	255,031
15 Dec. 14 :	871,600	810,300*	608,050	839,500*	559,400*	162,507	398,060*	238,029
16 Dec. 21 :	463,500	611,000	253,700	531,151	165,400	557,180	347,995	290,726*
17 Dec. 28 :	362,500	502,300	240,800	370,500	147,200	577,925*	306,465	93,220
18 Jan. 4 :	356,500	269,800	-	-	-	472,035	-	-
TOTAL DAYS	:	:	:	:	:	:	:	:
USE	:38,701,635	:29,338,960	:31,146,220	:34,130,467	:21,167,965	:20,036,268	:18,756,920	:14,080,850

\*Denotes peak population.

Note: Earliest peak occurred during 3rd week in November in 1953; latest peak occurred during last week in December in 1959; average peak occurs about the first week in December.

Table 9 - PEAK POPULATIONS BY SPECIES

Upper Mississippi Refuge

1953 thru 1960

Species	:	1953	:	1954	:	1955	:	1956	:	1957	:	1958	:	1959	:	1960	:
Mallard	:	145,170	:	70,720	:	101,050	:	185,900	:	104,150	:	71,225	:	45,236	:	57,900	:
Black	:	4,250	:	3,765	:	5,290	:	3,920	:	7,175	:	3,570	:	2,028	:	2,950	:
Gadwall	:	1,250	:	1,710	:	2,925	:	3,480	:	5,025	:	4,070	:	11,282	:	13,450	:
Baldpate	:	9,805	:	9,490	:	23,875	:	11,870	:	85,300	:	80,050	:	72,490	:	72,750	:
Pintail	:	15,950	:	16,535	:	12,880	:	8,420	:	16,225	:	23,000	:	9,737	:	12,825	:
G.w. teal	:	1,330	:	2,505	:	4,030	:	4,740	:	7,195	:	6,300	:	3,162	:	7,500	:
B.w. teal	:	23,874	:	17,370	:	24,050	:	36,000	:	50,000	:	35,300	:	27,650	:	20,100	:
Shoveller	:	680	:	678	:	490	:	1,290	:	1,270	:	1,395	:	605	:	1,525	:
Wood duck	:	12,420	:	11,150	:	12,050	:	11,400	:	11,550	:	8,950	:	11,240	:	18,425	:
Redhead	:	2,400	:	1,710	:	4,500	:	3,985	:	5,750	:	3,260	:	1,500	:	1,986	:
Ringneck	:	11,500	:	24,620	:	54,100	:	35,100	:	56,600	:	14,605	:	7,400	:	15,330	:
Canvasback	:	7,550	:	3,000	:	6,270	:	7,880	:	20,100	:	23,850	:	7,991	:	12,570	:
Scaup	:	53,500	:	48,380	:	93,000	:	30,700	:	56,700	:	33,300	:	75,939	:	38,650	:
Goldeneye	:	2,030	:	1,565	:	3,575	:	6,575	:	6,080	:	4,200	:	2,285	:	2,655	:
Bufflehead	:	159	:	330	:	1,335	:	930	:	315	:	410	:	2,071	:	470	:
Ruddy	:	300	:	724	:	735	:	1,240	:	1,030	:	435	:	501	:	470	:
Mergansers	:	745	:	2,110	:	1,925	:	3,280	:	3,020	:	3,770	:	2,125	:	2,375	:

Table 10 - AVERAGE DUCK DAY USE BY SPECIES  
 (1953 thru 1960)  
 ENTIRE FALL MIGRATION PERIOD

Species	: 8 years	: 7 years	: 7 years	: 3 years	: 8 years	: 8 years	: 8 years
	: Upper Miss. Refuge	: Louisa Unit	: Keithsburg Unit	: Gradner Unit	: Batchtown Unit	: Calhoun Unit	: ENTIRE AREA
Mallard	: 4,090,125	: 4,621,485	: 2,358,510	: 516,730	: 5,095,950	: 11,141,180	: 27,823,980
Amer. widgeon	: 1,585,650	: 7,780	: 1,295	: 830	: 101,370	: 289,900	: 1,986,825
Pintail	: 618,400	: 66,830	: 14,325	: 4,025	: 863,600	: 271,530	: 1,838,710
Scaup	: 1,401,715	: 11,035	: -	: 5,795	: 151,275	: 213,990	: 1,783,810
B.w. teal	: 912,660	: 4,650	: 2,275	: 1,155	: 127,440	: 226,360	: 1,274,540
Ringneck	: 717,735	: 4,405	: -	: 2,815	: 47,690	: 81,900	: 854,545
Wood duck	: 449,250	: 21,730	: 11,985	: 10,950	: 56,335	: 99,725	: 649,975
Canvasback	: 271,650	: 980	: -	: 320	: 30,275	: 77,650	: 380,875
Black	: 207,970	: 34,515	: 3,885	: 3,965	: 24,860	: 107,120	: 382,315
G.w. teal	: 169,530	: 11,715	: 1,980	: 1,820	: 35,790	: 82,560	: 303,395
Gadwall	: 131,910	: 5,515	: 920	: 1,060	: 24,040	: 40,950	: 204,395
Mergansers	: 75,570	: 820	: 25	: 3,590	: 20,210	: 53,550	: 153,765
Goldeneye	: 103,690	: -	: -	: 1,570	: 7,610	: 12,120	: 124,990
Redhead	: 82,800	: 210	: -	: 20	: 14,140	: 26,550	: 123,720
Shoveller	: 27,375	: 1,325	: 180	: 25	: 16,540	: 24,190	: 69,635
Ruddy	: 19,410	: 115	: -	: -	: 5,075	: 28,790	: 53,390
Bufflehead	: 13,250	: 10	: -	: 75	: 960	: 1,855	: 16,150
Other	: 375	: -	: 1	: -	: -	: -	: 376
AVERAGE	: : :	: : :	: : :	: : :	: : :	: : :	: : :
TOTAL DUCK DAY USE	: 10,879,065	: 4,793,120	: 2,395,381	: 554,745	: 6,623,160	: 12,779,920	: 38,025,391

Table 11 - COMPARATIVE DUCK DAY USE DURING HUNTING SEASONS

1953 through 1960

Year	8 years	7 years	7 years	3 years	8 years	8 years	8 years
	Upper Miss.	Louisa	Keithsburg	Gardner	Batchtown	Calhoun	ENTIRE
	Refuge	Unit	Unit	Unit	Unit	Unit	AREA
1953	7,656,551	-	-	-	26,707,800	5,634,300	39,998,651
1954	8,296,533	2,212,000	1,713,950	-	4,763,500	13,660,250	30,646,233
1955	8,871,345	3,117,450	3,579,800	-	1,668,800	19,572,000	36,809,395
1956	10,215,121	6,789,125	3,461,150	-	4,342,800	15,453,900	40,262,096
1957	12,275,312	9,727,550	3,186,400	-	1,659,875	5,270,475	32,119,612
1958	10,901,240	2,488,297	79,600	222,320	1,098,510	11,653,900	26,443,867
1959	6,340,000	2,904,440	1,296,580	593,260	2,236,500	3,161,550	16,532,330
1960	8,588,570	1,481,750	1,858,500	598,430	1,964,200	2,417,450	16,908,900
Average Duck							
Day Use During Hunting Season	9,143,100	4,102,940	2,168,000	471,340	5,555,250	9,603,000	29,965,010
Per Cent TOTAL							
Fall Use Occurring in Hunting Season	84.04	85.60	92.12	84.96	85.59	75.14	81.89

Table 12 - COMPARISON OF AVERAGE WEEKLY WATERFOWL POPULATIONS PRESENT DURING HUNTING SEASON  
 (1953 through 1960)

Year	8 years		7 years		7 years		3 years		8 years		8 years		8 years		
	Upper Miss.		Louisa	Keithsburg		Gardner		Batchtown		Calhoun		ENTIRE		Area	
	Refuge	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Area	Unit	Area	Unit
1953	:	100,800	:	-	:	-	:	-	:	456,700	:	89,430	:	646,930	:
1954	:	98,800	:	35,110	:	27,200	:	-	:	75,600	:	216,800	:	453,510	:
1955	:	105,600	:	40,500	:	53,250	:	-	:	23,850	:	279,600	:	502,800	:
1956	:	121,600	:	88,170	:	48,100	:	-	:	56,400	:	200,700	:	514,970	:
1957	:	134,900	:	126,330	:	41,380	:	-	:	22,165	:	69,280	:	394,055	:
1958	:	119,800	:	32,300	:	900	:	2,890	:	14,270	:	104,500	:	274,660	:
1959	:	89,760	:	51,990	:	26,575	:	12,100	:	45,650	:	64,500	:	290,575	:
1960	:	122,300	:	22,000	:	37,930	:	12,200	:	40,000	:	49,330	:	283,760	:
Average Weekly Population During Hunting Season	:	111,700	:	56,600	:	33,600	:	9,060	:	91,850	:	134,270	:	420,150	:

Table 13 - COMPARATIVE DUCK DAY USE BY SPECIES.....UPPER MISSISSIPPI REFUGE

1953 through 1960 Fall Seasons

Species	1953	1954	1955	1956	1957	1958	1959	1960	8-yr Average
Mallard	4,064,627	3,544,667	3,716,412	6,175,813	4,974,522	4,829,797	2,254,775	3,169,390	4,091,250
Black	256,214	331,863	243,586	155,743	254,506	186,249	89,509	146,097	207,970
Gadwall	48,335	73,500	84,392	95,270	127,855	138,635	188,489	298,802	131,900
Baldpate	462,945	437,150	873,180	582,799	2,404,731	2,529,702	2,352,581	3,042,130	1,585,650
Pintail	660,205	709,436	615,748	387,275	859,698	836,815	332,836	545,230	618,400
G.w. teal	67,760	97,090	153,790	225,715	229,292	270,795	101,444	210,350	169,500
B.w. teal	828,584	676,795	814,688	1,066,380	1,372,455	1,081,927	796,558	662,914	912,550
Shoveller	21,966	23,394	13,811	29,260	35,420	44,716	13,664	36,764	27,375
Wood duck	534,723	496,237	459,648	361,011	286,461	331,450	402,612	721,861	449,250
Redhead	57,442	62,300	109,172	101,745	131,775	91,105	33,292	75,586	82,800
Ringneck	291,018	797,930	1,204,147	933,870	1,194,690	638,960	241,017	440,251	717,725
Canvasback	138,215	99,715	149,835	234,080	492,590	473,382	204,218	381,192	271,650
Scaup	1,317,246	1,698,445	1,881,985	880,355	1,600,270	1,197,567	1,344,028	1,293,831	1,401,700
Goldeneye	51,674	51,982	112,665	153,860	179,109	120,190	82,565	77,476	103,700
Bufflehead	2,933	10,521	27,965	13,930	7,875	9,625	21,756	11,396	13,250
Ruddy	8,645	20,734	23,975	18,760	31,185	13,125	18,683	20,195	19,410
Mergansers	26,908	103,383	75,950	74,095	116,340	57,386	68,866	81,620	75,570
Other ducks	2,100	7	-	-	-	-	322	760	400
T O T A L	8,841,540	9,235,149	10,560,949	11,489,961	14,298,774	12,851,426	8,547,215	11,215,845	10,880,050

Note: Waterfowl use on the Upper Mississippi Refuge did not take a marked drop in 1957 (instead it increased) as was the case at Mark Twain. Apparently when the Missouri River reservoirs started holding birds, it had little effect on the populations using the Upper Mississippi, except for the southernmost portion. Any reduction in use in the Savanna-Clinton District was offset by increased use in the portions of the refuge north of there.

Table 14 - COMPARATIVE DUCK DAY USE BY SPECIES.....MARK TWAIN REFUGE

1953 through 1960 Fall Seasons

Species	1953	1954	1955	1956	1957	1958	1959	1960	8-yr Average
Mallard	32,444,300	25,866,330	28,277,900	29,764,700	18,662,175	17,241,161	16,677,815	11,372,865	22,538,400
Black	37,100	268,975	84,595	381,500	226,975	132,741	129,009	75,950	167,100
Gadwall	16,800	24,500	82,950	127,750	147,700	62,755	49,616	56,035	71,000
Baldpate	128,100	368,550	203,000	532,875	309,400	610,050	441,875	602,392	399,500
Pintail	5,096,000	1,087,800	535,250	832,250	582,575	331,352	214,689	722,351	1,175,300
G.w. teal	52,535	173,075	222,250	172,550	128,800	53,312	66,042	179,557	131,000
B.w. teal	452,200	554,050	526,400	622,055	102,725	322,483	176,036	126,462	360,300
Shoveller	28,000	54,250	40,600	77,000	74,900	25,137	12,775	23,800	42,050
Wood duck	116,900	99,225	154,000	215,180	111,825	151,515	374,955	287,749	188,900
Redhead	21,000	35,000	35,000	113,400	51,100	46,305	16,450	8,806	40,880
Ringneck	46,200	306,600	123,900	186,900	205,100	78,400	7,140	121,751	134,500
Canvasback	12,600	77,455	227,150	308,000	138,600	72,100	16,548	18,809	108,900
Scaup	230,300	343,700	506,975	390,600	263,900	526,428	362,390	392,462	674,000
Goldeneye	10,500	15,400	20,650	14,000	36,400	20,755	23,240	21,623	20,300
Bufflehead	350	1,400	3,150	6,300	-	10,640	721	266	2,850
Ruddy	6,650	32,200	26,950	51,100	26,250	48,720	45,920	33,901	33,950
Mergansers	21,000	30,800	45,500	34,300	98,700	303,044	36,680	36,064	75,750
T O T A L	38,720,535	29,339,310	31,116,220	33,830,460	21,167,125	20,036,898	18,651,901	14,080,843	26,164,680

Note: 1953 data for Batchtown and Calhoun Units; 1954-1957 data includes Louisa, Keithsburg, Batchtown and Calhoun Units; while 1958-1960 data included Louisa, Keithsburg, Gardner, Batchtown and Calhoun Units.

Note the big drop in use starting with the 1957 season. That was the year in which impoundments on the Missouri River started holding ducks. Apparently many ducks come to Mark Twain from a northwesterly direction, possibly from those populations which are now using the Missouri reservoirs. While ducks move south along the Mississippi River from the Upper Mississippi Refuge, a portion of Mark Twain birds are known to enter the valley from the northwest, arriving south of the Upper Mississippi Refuge.

during the hunting season on the Upper Mississippi Refuge amounts to 111,700 ducks, while for the entire area the average weekly population during the open season is 420,150 ducks. Thus it can be seen that duck populations during the period of hunting are high enough to provide a good supply of birds for the hunters. These data are shown in tables 10 through 14.

#### Species composition of the flight

Over the entire area, mallards account for 72.40% of the total duck flight. On the Upper Mississippi Refuge, there is a more balanced composition, with mallards accounting for only 37.60% of the total flight, while widgeons follow with 14.58% and scaup come third with 12.88%. Wood ducks represent 4.13% of total fall populations on the Upper Mississippi Refuge alone, but only 1.74% on the combined areas.

Table 15 shows that while mallards account for only 37.60% of total use on the Upper Mississippi, they account for almost all of the use on Mark Twain. This difference is believed due to a southeasterly movement of mallards which reach the Mississippi River. In some years this is a late season movement, accounting for peak populations on Bathtown and Calhoun Refuges late in December. Species composition of the fall flight is shown in table 15.

#### Mass migrations

One of the best-known mass migrations of waterfowl occurred prior to the period of this study. This movement took place during the Armistice Day (November 11) storm of 1940. Comparatively few ducks were present on the refuge prior to that storm. Armistice Day dawned bright and sunny, with little indication that by mid-day there would be an abrupt change in the weather. By noon, ducks started moving down the valley by the thousands, riding ahead of a storm front that pushed almost all the ducks before it; and by the next day when the storm had subsided most of the waterfowl had moved south. Never in the memory of hunters in this vicinity had so many ducks moved through in so short a time.

Mass migrations were observed in 4 of the 15 years involved in this study. Those years were 1947, with a heavy flight on November 6 - 10; 1948, with two good movements on November 6 - 7 and December 3 - 8; 1955, when on November 1 - 3 one of the heaviest flights in years occurred; and 1956, when a mass flight took place on November 7 - 9, but not comparable to the 1955 movement. In 1959, an early freeze pushed most ducks out of the Upper Mississippi Refuge between November 14 and 21, but the overall picture remained unchanged because of a late-season build-up of mallards on Mark Twain.

Table 15 - AVERAGE SPECIES COMPOSITION OF POPULATIONS, IN PER CENT  
 (Since Duck Day Use Data Started in 1953)

In Descending Order of Importance

Species	8-years	7-years	7-years	3-years	8-years	8-years	8-years
	: Upper Miss.:	Louisa	: Keithsburg	Gardner	Batchtown	Calhoun	E N T I R E :
	: Refuge	: Unit	: Unit	: Unit	: Unit	: Unit	: AREA
Mallard	37.60	95.21	98.46	93.15	76.94	87.18	72.40
Baldpate	14.58	.27	.05	.15	1.53	2.27	5.39
Pintail	5.68	1.81	.60	.73	13.04	2.12	4.96
Scaup	12.88	.41	-	1.04	2.28	1.67	4.84
B.w. teal	8.39	.15	.09	.21	1.93	1.77	3.46
Ringneck	6.60	.15	-	.51	.72	.64	2.32
Wood duck	4.13	.64	.50	1.97	.85	.78	1.74
Canvasback	2.50	.04	-	.06	.46	.61	1.03
Black	1.91	.58	.16	.71	.38	.84	1.02
G.w. teal	1.56	.42	.08	.33	.54	.65	.88
Gadwall	1.21	.21	.04	.19	.36	.32	.55
Mergansers	.69	.02	t	.65	.31	.42	.41
Goldeneye	.95	-	-	.28	.11	.09	.34
Redhead	.76	.01	-	t	.21	.21	.33
Shoveller	.25	.05	.01	t	.25	.19	.19
Ruddy	.18	t	-	-	.08	.23	.15
Bufflehead	.12	t	-	.01	.01	.01	.04
Other ducks	.01	-	t	-	-	-	.01

During the other 10 years there was a steady dribble of birds through the valley, leading to a build-up in populations. Even in those years, several periods of good flights occurred, but not in the nature of "mass migrations" of 1947, 1948, 1955, or 1956. The following chart very briefly summarizes the movements each fall:

<u>Year</u>	<u>Major Flight</u>
1940	Armistice Day flight was heaviest on record.
1946	Heavy flight recorded November 6-10.
1947	Two periods of heavy flight: November 6-7 and December 3-8.
1948	Steady movement through, with no heavy migrations.
1949	Steady movement, with no heavy migration.
1950	"Bluebird weather," with no mass flight; best movement on November 7-10.
1951	Steady dribble; best movements on October 7, 18, 31, and November 4.
1952	Steady movement, but two "peaks" - October 19-25 and during blizzard of November 9-15.
1953	Steady flight; 92% increase in duck day use over 1952.
1954	Steady flight, with three fair movements: November 1, November 23-27, and December 5.
1955	Mass movement on November 2 was the heaviest single flight since Armistice Day, 1940.
1956	Heavy movement November 7-9, but not comparable to 1955.
1957	Steady flight. Best October 26 and November 2, and the peak on November 9. Drop of 40.9% in mallard numbers below 1956.
1958	Steady dribble; heavy movement out of Upper Mississippi in mid-November; late mallard build-up on Mark Twain.
1959	Steady dribble. Best movement in late October and November 4-5. Mallards down 41.8% below 1958.
1960	Steady flight. Good movement in late October and December 3. Mallards again down 23% below 1959.

## SUMMARY OF HUNTING CONDITIONS

### Area available for public hunting

Two different systems of management have been used on the Upper Mississippi and Mark Twain Refuges from their very inception. On the Upper Mississippi Refuge the entire area of 194,000 acres is administered by the Bureau of Sport Fisheries and Wildlife. A series of strategically located closed areas or sanctuaries are spread throughout the refuge and all remaining lands are open to public hunting. Although from time to time there have been different patterns of closed areas on the Upper Mississippi Refuge, the basic approach has remained unchanged. As many as 19 closed areas have been in effect in the past. Prior to the hunting season of 1957 the closed areas on the refuge were radically changed as the result of many years of thought and study. The original closed areas were often selected on the basis of ownership alone since the Bureau did not have consolidated control over bottomlands within the authorized limits of the refuge. With the consummation of the General Plan and Cooperative Agreement with the Corps of Engineers in 1954, refuge staffs were in a position for the first time to examine the refuge closed area program in the light of biological requirements instead of land ownership. The changes were accordingly made in the summer of 1957. The current plan provides for 14 closed areas. However, the proportion of "open" vs. "closed" areas has remained essentially the same. At present, the 14 closed areas include 40,775 acres of sanctuary, accounting for 21% of the refuge ownership; while the remaining 153,225 acres, or 79% of the ownership, is open to public hunting on a "first-come-first-served" basis. This no doubt constitutes one of the most extensive units of Bureau-controlled public hunting in existence today, at least as far as waterfowl hunting is concerned.

On the Mark Twain Refuge an entirely different approach was used. There the Bureau retained control of lands in five separate units, while the remaining lands which were made available to the Bureau under cooperative agreement with the Corps of Engineers were turned over to the various States for management. The States are using these lands mostly for public hunting areas, although a few small sanctuaries are provided by them. In Iowa, 7,414 acres of open public hunting lands offered to the State were returned to the Bureau so that the latter agency is currently providing public hunting on that portion.

In the vicinity of the Bachtown and Calhoun Units of Mark Twain Refuge, the State of Illinois has instituted a system of rather close supervision over hunters. The State is assigning waterfowl blind space (although the successful applicants construct

their own blinds, and have prior right to them provided they are occupied prior to the opening hour each day), and manning check stations through which hunters must report on leaving the hunting areas.

No waterfowl hunting is permitted on any unit of Mark Twain Refuge, so that all bag-check information gathered pertains to hunting on adjoining lands where the birds came from the Refuge Units.

#### Waterfowl hunting season dates

Table 16 shows waterfowl hunting dates for the entire area over the 15-year period of this study. Note that the earliest date in any State during that period was October 1, and the latest open date was December 27.

#### Hunting pressure

Data on estimated total hunting pressure in the areas checked are available for only a portion of the 15 years that bag-check data have been accumulated. It was not until 1953 that a concerted effort was made to attempt to estimate total days of hunting done in most areas.

Since 1953 there has been an average of 102,920 days of waterfowling on the Upper Mississippi Refuge (highest was 129,845 in 1957); 5,345 days in the vicinity of Louisa Unit of Mark Twain (highest 8,700 in 1960); an average of 1,470 days near Keithsburg (highest 4,300 days in 1955); an average of 3,375 days near Gardner (highest 4,224 days in 1960); an average of 10,365 days near Batchtown (highest 13,200 days in 1956); and an average of 17,905 days near Calhoun (highest 29,750 days in 1954). These data are shown in table 17.

#### Number of hunters checked

During the 15-year period from 1946 through 1960, a total of 251,876 hunters having 283,763 ducks have been checked along the Mississippi River. (This includes 1,643 hunters with 2,770 ducks checked in 1954, 1955, and 1956 at Middleton Island, Pool 24; and 682 hunters with 988 ducks, checked at the Oquawka Area in 1957.) These 251,876 hunters thus averaged 1.12 ducks per day of hunting. Checks were made as follows:

Area	Average	Checked	Per Year	TOTAL	NUMBER	CHECKED
	Hunters	Ducks	Daily Av.	Hunters	Ducks	
Upper Miss. Refuge	4,821	5,935	1.23	72,316	89,039	
Louisa Unit	1,064	1,458	1.37	13,837	18,958	
Keithsburg Unit	122	93	.76	859	651	
Oquawka Area	548	923	1.68	682	988 *	
Gardner Unit	3,227	2,258	.69	12,911	9,035	
Middleton Island	682	988	1.44	1,643	2,770 **	
Batchtown Unit	4,029	5,536	1.37	56,409	77,504	
Calhoun Unit	6,214	5,654	.90	93,219	84,818	
<b>TOTAL</b>			<b>1.12</b>	<b>251,876</b>	<b>283,763</b>	

\* Oquawka Area checked only in 1957.

\*\* Middleton Island (Pool 24) checked in 1954, 1955 and 1956.

Note: Hunting on all except the Upper Mississippi Refuge was done in the vicinity of the units; no hunting permitted on units proper.

#### Summary of Hunting Success

During the past 15-years there has been a great variation in daily hunting success ranging from a high of 2.54 ducks per day at Keithsburg in 1955 to a low of 0.56 ducks per day at Gardner in 1960. The highest average recorded in any one year for the entire area was 1.64 ducks per day in 1949; the lowest was 0.93 in 1958; and the overall average for the 15-year period was 1.12 ducks per day.

Average annual daily bags and more specific information on hunters checked each year are shown in table 18.

The number of hours a hunter puts in each day while hunting ducks has remained fairly constant over the years, ranging from a minimum of 4.64 hours per hunt on the Upper Mississippi Refuge to a high of 6.35 hours per day at Louisa Unit. Along the entire river the daily hunt averages 5.26 hours.

Perhaps the difference in hours expended is due to the type of hunting and the type of hunters in the various areas. On the Upper Mississippi Refuge most shooting is done from blinds and in the marshes where there is a good chance to harvest most of the puddlers and some of the divers. Most hunters have good equipment, particularly boats and decoys, which are needed for this type of hunting. Hunters there will normally take almost any duck that comes along, although there are some who try for certain species. On the lower river hunters seem to prefer mallards, and

Table 16 - WATERFOWL HUNTING SEASON DATES AND BAG LIMITS

1946 through 1960

Year	Total Days	Bag Limit	Minnesota	Wisconsin	Iowa	Illinois
1946	45	(7 birds)	Oct. 5 - Nov. 18	Oct. 5 - Nov. 18	Oct. 26 - Dec. 9	Oct. 26 - Dec. 9
1947	30	(4 birds)	Oct. 7 - Nov. 5	Oct. 21 - Nov. 19	Oct. 21 - Nov. 19	Nov. 4 - Dec. 3
1948	30	"	Oct. 8 - Nov. 6	Oct. 15 - Nov. 13	Oct. 29 - Nov. 27	Oct. 29 - Nov. 27
1949	40	"	Oct. 7 - Nov. 15	Oct. 14 - Nov. 22	Oct. 21 - Nov. 29	Nov. 4 - Dec. 13
1950	35	"	Oct. 6 - Nov. 9	Oct. 14 - Nov. 16	Oct. 20 - Nov. 23	Nov. 3 - Dec. 7
1951	45	"	Oct. 5 - Nov. 18	Oct. 13 - Nov. 25	Oct. 12 - Nov. 25	Oct. 26 - Dec. 9
1952	55	"	Oct. 1 - Nov. 24	Oct. 4 - Nov. 27	Oct. 8 - Dec. 1	Oct. 20 - Dec. 13
1953	55	"	Oct. 3 - Nov. 26	Oct. 3 - Nov. 26	Oct. 8 - Dec. 1	Oct. 23 - Dec. 16
1954	55	"	Oct. 2 - Nov. 25	Oct. 2 - Nov. 25	Oct. 15 - Dec. 8	Oct. 22 - Dec. 15
1955	70	"	Oct. 8 - Dec. 16	Oct. 1 - Dec. 9	Oct. 8 - Dec. 16	Oct. 15 - Dec. 23
1956	70*	"	Oct. 6 - Nov. 29	Oct. 1 - Dec. 9	Oct. 6 - Dec. 14	Oct. 13 - Dec. 21
1957	70	"	Oct. 5 - Dec. 13	Oct. 1 - Dec. 9	Oct. 5 - Dec. 13	Oct. 19 - Dec. 27
1958	70	"	Oct. 4 - Dec. 12	Oct. 1 - Dec. 9	Oct. 4 - Dec. 12	Oct. 18 - Dec. 26
1959	50**	"	Oct. 7 - Nov. 25	Oct. 7 - Nov. 25	Oct. 20 - Dec. 8	Oct. 30 - Dec. 8
1960	50***	"	Oct. 8 - Nov. 16	Oct. 7 - Nov. 25	Oct. 15 - Dec. 3	Oct. 28 - Dec. 6

\* Minnesota elected a 55-day season, with experimental 5-bird limit.

\*\* Minnesota, Wisconsin, and Iowa took 50-day season and 3-bird limit; Illinois took 40 days and 4-bird limit.

\*\*\* Minnesota and Illinois took 40-day season and 4-bird limit; Wisconsin and Iowa took 50 days and 3-bird limit.

Table 17 - SUMMARY OF HUNTING PRESSURE

1953 - 1960

## Man Days of Hunting

Year	8 years		7 years		5 years		4 years		7 years		7 years		8 years	
	Upper Miss.		Louisa	Keithsburg		Gardner	Batchtown		Calhoun		ENTIRE			
	Refuge	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Unit	Area	
1953	101,550	-	-	-	-	-	-	-	-	-	-	-	101,550	
1954	129,700	3,110	785	-	-	-	12,940	-	29,750	-	178,285*	-		
1955	114,380	6,550	4,300	-	-	-	12,000	-	24,000	-	162,730**	-		
1956	114,265	4,950	1,430	-	-	-	13,200	-	15,995	-	151,840***	-		
1957	129,845	5,450	-	-	4,000	-	12,000	-	17,000	-	169,495****	-		
1958	111,335	3,110	-	-	3,500	-	7,000	-	16,000	-	140,945	-		
1959	57,315	5,550	500	-	1,773	-	7,260	-	9,395	-	81,793	-		
1960	65,000	8,700	350	-	4,224	-	8,150	-	13,200	-	99,624	-		
AVERAGE	102,920	5,345	1,470	-	3,375	-	10,365	-	17,905	-	135,785	-		

\* includes 2,000 days of hunting in Pool 24.

\*\* includes 1,500 days of hunting in Pool 24.

\*\*\* includes 2,000 days of hunting in Pool 24

\*\*\*\* includes 1,200 days of hunting at Oquawka, Pool 18.

Table 18 - SUMMARY OF HUNTERS CHECKED AND AVERAGE BAGS

By Area - 1946 through 1960

	Upper Mississippi	Louisa Unit	Keithsburg Unit	Gardner Unit	Batchtown Unit	Calhoun Unit	ENTIRE AREA								
Year	Number of hunters	Number of ducks	Number per day	Number of hunters	Number of ducks	Number per day	Number of hunters	Number of ducks	Number per day	Number of hunters	Number of ducks	Number per day	Number of hunters	Number of ducks	Number per day
1946	1,934	2,920	1.50	256	489	1.90							445	539	1.21
1947	2,543	3,457	1.35										2,635	3,948	1.50
1948	2,856	3,653	1.27										4,152	2,543	1.53
1949	3,410	5,866	1.72	353	458	1.29							576	632	1.09
1950	5,865	5,490	.93	301	292	.97							4,218	6,238	1.45
1951	2,976	5,172	1.73	588	1,236	2.10	60	71	1.18				1,947	2,884	1.48
1952	5,267	6,912	1.31	488	640	1.31							1,745	1,693	.97
1953	4,237	5,340	1.26	364	369	1.01	80	104	1.30				535	926	1.73
1954	6,774	6,826	1.01	487	751	1.54	104	86	.83				3,061	4,012	1.31
1955	6,447	7,339	1.14	450	820	1.82	37	94	2.54				2,449	3,140	1.28
1956	5,852	6,777	1.16	1,326	2,189	1.65	83	47	.56				3,372	3,468	1.02
1957	5,755	7,462	1.30	1,185	2,904	2.45							6,061	6,061	1.56
1958	7,419	8,275	1.12	904	1,113	1.23							6,185	3,652	.59
1959	5,017	5,769	1.14	541	933	1.72	157	79	.51	1,570	1,061	.68	14,796	15,526	1.05
1960	5,964	7,782	1.30	6,594	6,764	1.02	338	170	.50	4,224	2,405	.56	7,212	11,410	1.58
TOTAL	72,316	89,039	1.23	13,837	18,958	1.37	859	651	.76	12,911	9,035	.69	56,409	77,504	1.37
AV.	4,821	5,935	1.23	1,064	1,458	1.37	122	93	.76	3,227	2,258	.69	4,029	5,536	1.37

\* includes 662 hunters with 1,132 ducks checked in Pool 24

\*\* includes 495 hunters with 745 ducks checked in Pool 24

\*\*\* includes 486 hunters with 893 ducks checked in Pool 24

\*\*\*\* includes 682 hunters with 988 ducks checked at Oquawka

\*\*\*\*\* includes 1,750 hunters with 750 ducks checked at the Long Island area and  
2,474 hunters with 1,655 ducks checked in Quinoy Bay (shown in table as  
Gardner Area)

often hunt in areas where field-feeding mallards are most apt to be taken. This type of hunting is often more convenient and requires less effort and less equipment. This indicates that hunters are willing to spend more time afield even though their time is not as productive per hour as is the case on the Upper Mississippi Refuge.

There is a tremendous difference in hourly success rate, too, with the Upper Mississippi requiring an average of 3.98 hours of hunting for each duck bagged; Louisa 4.44 hours; Keithsburg 5.72 hours; Gardner 7.35 hours; Bachtown 4.98 hours; Calhoun 6.37 hours; and the entire area averaging 4.95 hours of hunting for each duck brought to bag. On the Upper Mississippi Refuge, in 1949, the very low figure of 2.69 hours per duck was found. Again, the type of hunter, the type of hunting, and hunter selectivity may be factors in the variation between the areas.

A summary of comparative hourly success for all areas is shown in tables 19 and 20.

#### Species composition of bag

With mallards comprising the bulk of the flight through this area, it is not surprising to find that this species dominates the bag. On the Upper Mississippi Refuge, for example, mallards made up 37.60% of the total duck use, yet constituted 40.30% of the average bag. For the area as a whole, mallards comprised 72.40% of the total use and 62.90% of the checked kill.

Blue-winged teal, on the other hand, made up only 8.39% of the total average fall use on the Upper Mississippi yet accounted for 18.14% of the checked kill. On the same area, wood ducks accounted for 4.13% of fall use but 7.46% of the checked kill. This is all the more surprising when one considers the number of years during which this species has been given complete or partial protection.

Scaup, on the other hand, accounted for 12.88% of average fall use on the Upper Mississippi but only 3.02% of the checked kill.

It would appear that for most species the relation between use and harvest is about what could be expected. The disproportionately high incidence in the bags of such species as blue-winged teal and wood ducks suggests that these species may be more vulnerable to the gun than some others. Records also indicate that the bulk of the kill of these ducks occurs within the first week of the hunting season with as much as 89% of opening day kill being blue-winged teal and about 80% of the total fall harvest being concentrated on the opening day. To a more limited degree, the same holds true with wood ducks.

Table 19 - SUMMARY OF HOURLY SUCCESS DATA

	Upper Miss.		Louisa		Keithsburg		Gardner		Batchtown		Calhoun		ENTIRE AREA	
Year	Hrs. hunted	Per day	Hrs. hunted	Per duck	Hrs. hunted	Per day								
1947	4.01	3.76	-	-	-	-	-	-	-	-	-	-	4.01	3.76
1949	4.63	2.69	7.13	5.50	-	-	-	-	7.18	4.20	6.30	4.17	4.63	2.69
1950	4.51	4.81	6.21	6.40	-	-	-	-	6.91	4.66	5.86	6.04	5.27	5.02
1954	4.64	4.61	6.08	3.95	4.92	5.95	-	-	-	-	4.76	5.13	4.76	4.64
1955	4.68	4.11	6.70	3.68	5.62	2.21	-	-	6.70	4.23	6.04	6.24	5.91	4.86
1956	4.76	4.05	7.95	4.82	5.10	9.00	-	-	6.17	5.12	5.76	6.69	5.76	5.32
1957	5.27	4.07	7.06	2.88	-	-	5.93	6.63	6.24	4.70	6.06	6.84	6.00	6.84
1958	4.75	4.28	6.03	4.90	-	-	4.86	7.53	6.26	6.92	5.28	6.03	5.28	5.72
1959	4.76	4.13	4.39	2.54	-	-	5.05	7.34	6.69	4.66	5.34	8.55	5.55	5.44
1960	4.39	3.36	5.64	5.28	-	-	4.50	7.92	6.58	5.32	5.74	5.64	5.45	5.16
AVERAGE	4.64	3.98	6.35	4.44	5.21	5.72	5.08	7.35	6.59	4.98	5.74	6.37	5.26	4.95

Note: Hourly data in 1947 obtained only from Upper Mississippi Refuge; these data were transferred to the "Entire Area" column in that year, as they were all the data available.

**Table 20 - RELATIONSHIP BETWEEN SEASON LENGTH, DAILY BAG LIMIT,  
AND AVERAGE HOURS HUNTED PER DAY**

Year	Season	No. days in Season	Daily Bag Limit	Average Hours Hunted Per Day						ENTIRE AREA
				Upper Miss.	Louisa	Keithsburg	Gardner	Batchtown	Calhoun	
1947	30	30	4	4.01						4.01
1949	40	40	4	4.63	7.13			7.18	6.30	4.63
1950	35	35	4	4.51	6.21			6.91	5.86	5.27
1954	55	55	4	4.64	6.08	4.92			4.76	4.76
1955	70	70	4	4.68	6.70	5.62		6.70	6.04	5.91
1956	70*	70*	4*	4.76	7.95	5.10		6.17	5.76	5.76
1957	70	70	4	5.27	7.06		5.93	6.24	6.06	6.00
1958	70	70	4	4.75	6.03		4.86	6.26	5.28	5.28
1959	40-50**	40-50**	3-4**	4.76	4.39		5.05	6.69	5.34	5.55
1960	40-50***	40-50***	3-4***	4.39	5.64		4.50	6.58	5.74	5.45
AV.				4.64	6.35	5.21	5.08	6.59	5.74	5.26

\* Minnesota elected 55-day season and daily limit of 5 ducks

\*\* Minnesota, Wisconsin and Iowa elected a 50-day season and limit of 3; Illinois took 40-day season and limit of 4

\*\*\* Minnesota and Illinois elected a 40-day season and limit of 4; Wisconsin and Iowa elected 50-day season and limit of 3

Note that the length of season or the daily bag limit appears to have little effect on the time spent afield along the Mississippi River.

With scaup, on the other hand, the low harvest in proportion to the population, probably reflects more the type of hunting than vulnerability, since most of the hunting along the river in the areas checked is done from blinds and in the marshes rather than on open river "points." The same holds true for canvasbacks which comprise 2.50% of fall use on the Upper Mississippi but only 0.93% of the checked kill; while for the entire area, this species makes up 1.03% of total use and 0.50% of the checked kill.

Tables 21 and 22 compare the species composition in the fall flight with the species composition in the checked kill, together with the number of years for each category from which data are available. All figures shown in these tables are average figures based on length of time the data cover.

#### Comparative vulnerability of species

Since duck species were represented in different abundance in the population and in the harvest, there is probably a difference in vulnerability to gunning. Vulnerability, as considered here, encompasses all facets of the harvest and recognizes that there is a difference in the way in which the various species are taken. Whether this depends on being more vulnerable to the gun, a preference by hunters, weather conditions, response to decoys, or the type of hunting done is of little consequence. The important thing is that for a given segment of the population present, some birds are taken in a higher ratio than are others. Vulnerability, thus, relates entirely to the ratio of harvest per unit of population, regardless of why these different ratios apply.

In comparing the data, it became apparent that within rather close limits, mallards were present in about the same relative abundance in both the population and the harvest. They accounted for 37.60% of the population and 40.30% of the checked kill. Since these figures were so close, it was decided to arbitrarily assign a vulnerability rating of 1 to mallards and to compare all other species to them.

Using the above percentages for mallards (37.60% in the population - 40.30% in the checked kill) as a base, the mallard index was obtained by dividing the percentage of the checked kill by the percentage in the population which gave an index of 1.07 for mallards. This was then arbitrarily set up as a vulnerability rating of 1.

For black ducks, it was found that they accounted for 1.91% of the population on the Upper Mississippi Refuge and 2.28% of the checked kill. Dividing as before, an index of 1.19 was obtained. To correct this on the same basis as for mallards, the following formula was used:

Table 21 - RELATIONSHIP BETWEEN SPECIES COMPOSITION

In the Fall Population (Days Use) and in the Checked Kill

On Percentage Basis

Species	Upper Miss.	Lower	Keithsburg	Gardner	Batchtown	Calhoun	ENTIRE
	Refuge	Unit	Unit	Unit	Unit	Unit	AREA
	Total days use:	Total Kill	Total days use:	Total Kill	Total days use:	Total Kill	Total days use:
Mallard	37.60	40.30	95.21	83.08	98.46	95.28	72.40
Black	1.91	2.28	.58	.39	.16	.40	62.90
Gadwall	1.21	1.33	.21	.85	.04	-	1.48
Baldpate	14.58	8.30	.27	1.20	.05	.82	1.13
Pintail	5.68	7.04	1.81	2.74	.60	1.30	4.45
G.w. teal	1.56	5.97	.42	2.04	.08	.67	4.27
B.w. teal	8.39	18.14	.15	2.05	.09	.30	8.35
Shoveller	.25	.80	.05	.36	.01	.41	.87
Wood duck	4.13	7.46	.64	4.15	.50	.82	4.64
Redhead	.76	.70	.01	.18	-	-	.44
Ringneck	6.60	3.13	.15	.30	-	-	1.59
Canvasback	2.50	.93	.04	.28	-	-	.50
Scaup	12.88	3.02	.41	2.25	-	-	2.46
Goldeneye	.95	.15	-	.07	-	-	.10
Bufflehead	.12	.11	t	.01	-	-	.08
Ruddy	.18	.16	t	.02	-	-	.13
Mergansers	.69	.10	.02	.03	t	-	.07
Other ducks	.01	.08	-	-	t	-	.03
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00
No. years							
data	8 yrs.	15 yrs.	7 yrs.	13 yrs.	7 yrs.	4 yrs.	8 yrs.

Table 22 - SPECIES COMPOSITION OF DUCKS CHECKED IN HUNTERS' BAGS  
 (On percentage basis)

Over period of study

Species	: 15 years	: 13 years	: 7 years	: 4 years	: 14 years	: 15 years	: 15 years	
	: Upper Miss.	Louisa	: Keithsburg	Gardner	: Batchtown	Calhoun	E N T I R E	
	: Refuge	: Unit	: Area	*				
Mallard	: 40.30	: 83.08	: 95.28	: 87.73	: 82.79	: 73.25	: 62.90	:
Black	: 2.28	: .39	: .40	: .23	: .36	: .75	: 1.48	:
Gadwall	: 1.33	: .85	: -	: .85	: .31	: 1.29	: 1.13	:
Baldpate	: 8.30	: 1.20	: .82	: 1.48	: .83	: 3.18	: 4.45	:
Pintail	: 7.04	: 2.74	: 1.30	: 1.05	: 8.40	: 4.87	: 6.51	:
G.w. teal	: 5.97	: 2.04	: .67	: 2.58	: 1.80	: 5.01	: 4.27	:
B.w. teal	: 18.14	: 2.05	: .30	: .67	: 1.35	: 3.28	: 8.35	:
Shoveller	: .80	: .36	: .41	: .30	: .27	: 1.41	: .87	:
Wood duck	: 7.46	: 4.15	: .82	: .79	: .34	: 2.22	: 4.64	:
Redhead	: .70	: .18	: -	: .25	: .34	: .36	: .44	:
Ringneck	: 3.13	: .30	: -	: .50	: 1.06	: .56	: 1.59	:
Canvasback	: .93	: .28	: -	: .10	: .35	: .28	: .50	:
Scaup	: 3.02	: 2.25	: -	: 3.07	: 1.60	: 3.00	: 2.46	:
Goldeneye	: .15	: .07	: -	: .05	: .04	: .15	: .10	:
Bufflehead	: .11	: .01	: -	: .16	: .06	: .07	: .08	:
Ruddy	: .16	: .02	: -	: .02	: .09	: .17	: .13	:
Mergansers	: .10	: .03	: -	: .15	: .01	: .11	: .07	:
Other ducks	: .08	: -	: -	: .02	: -	: .04	: .03	:
<b>TOTAL</b>	<b>: 100.00</b>							

\*This percentage composition is based on an average total figure, and differs from the percentages arrived at by totaling weighted averages resulting from computing species harvest from individual areas. See table 30 on page 46.

1.07 (mallard index) : 1.00 (mallard rating) =  
1.19 (black duck index) : X

or  $\frac{1.15}{1.07} = 1.07$  (corrected rating for black ducks)

Thus, black ducks have a vulnerability rating that is 1.07 times as great as for mallards on the Upper Mississippi.

The same formula was used for all species, for all areas and all periods, and tables 23 and 24 were worked out. (See pages 38 and 39.)

By assigning these vulnerability ratings it is possible to not only compare other species to mallards, but also the comparative vulnerability between any species can be determined. For example, gadwall have a rating of 1.01 and blue-winged teal a rating of 2.01. Therefore, blue-winged teal are twice as vulnerable under hunting conditions in this area as are gadwall. Scaup have a rating of 0.21 compared with green-winged teal with a rating of 3.57. Thus, under conditions here, green-winged teal are 17 times as vulnerable as are scaup. This, of course, would not be true in an area where point or open-river shooting predominated, but it does apply to this area where most of the shooting is done in the marshes and mostly from blinds.

Tables 24 and 25 compare the percentage composition of the population and the checked kill on the Upper Mississippi Refuge for the opening week of the hunting season and for the entire season. Note that the tables are broken down into three segments: (1) the period 1953 thru 1958 when the latest opening was October 3; (2) the period 1959 and 1960 when the season opened on October 7; and (3) the entire period 1953 thru 1960. This was done to illustrate the difference in both populations and harvest that occur within the various segments. An opening delayed only 1 week makes a tremendous difference in the composition, especially with blue-winged teal. It will be noted that with the season opening between October 1 and 3, blue-wings averaged 27.87% of the population present and 48.31% of the checked kill. With the opening delayed to October 7, this species made up only 9.35% of the population and 28.71% of the checked kill. Oddly enough, in the period 1953 thru 1958, with more blue-wings present in both the population and the checked kill, they had a vulnerability rating of 1.78, while from 1959 thru 1960 the rating was 3.07. Thus, although fewer blue-wings were present in the latter 2 years, those which were present were taken at a much higher rate per unit of population than for the 1953-58 seasons which had higher numbers present in both the population and the checked kill.

Table 23 - COMPARATIVE VULNERABILITY OF SPECIES

1953 through 1960 Seasons

(All species compared to MALLARDS, which have been assigned a rating of "1.00")

Species	UPPER MISS	LOUISA	KEITHSBURG	GARDNER	BATHTOWN	CALHOUN	E N T I R E
	REFUGE	Unit	Unit	Unit	Unit	Unit	AREA
	First Week	Entire Season	First Week	Entire Season	First Week	Entire Season	First Week
Mallard	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Black	.44	1.07	.28	.77	-	2.60	2.22
Gadwall	.85	1.01	.70	4.64	-	-	2.82
Baldpate	.41	.52	2.92	5.10	-	17.08	6.78
Pintail	.42	1.14	2.48	1.73	-	2.25	1.40
G.w. teal	1.98	3.57	4.72	5.57	-	8.71	5.20
B.w. teal	1.78	2.01	14.52	15.70	-	3.46	-
Shoveller	.88	2.99	-	8.27	-	42.70	-
Wood duck	.61	1.68	1.75	7.44	-	1.70	1.12
Redhead	1.69	.85	-	20.68	-	-	1.61
Ringneck	1.66	.44	.51	2.30	-	-	1.04
Canvasback	.32	.34	-	8.04	-	-	.51
Scaup	.38	.21	.14	6.30	-	-	.66
Goldeneye	-	.14	-	-	-	-	.18
Bufflehead	1.92	.85	-	-	-	-	17.00
Ruddy	.84	.82	-	-	-	-	.16
Mergansers	.11	.13	-	1.72	-	-	6.67
							.24
							.03
							50.00
							.20

Note: These data were obtained as follows: the percentage of the checked kill was divided by the percentage of the population to obtain an index. Since the percentage of mallards in the checked kill and in the population was nearly equal, the index for that species was corrected to a rating of "1.00," and the index for all other species were similarly corrected. The rating thus obtained compares the apparent vulnerability of other species to mallards. Thus, if in the last column green-winged teal have a rating of 6.05, they have an apparent vulnerability in this particular area that is 6.05 times as great as mallards; baldpates are only 0.95 times as vulnerable, etc.

Data for wood ducks, redheads and canvasbacks are complicated by whole or partial protection on these species during some years of the study.

Table 24 - RELATIVE VULNERABILITY OF SPECIES

Upper Mississippi Refuge Area ONLY

Species	PERCENTAGE COMPOSITION DURING FIRST WEEK OF THE WATERFOWL HUNTING SEASON												E N T I R E      H U N T I N G      S E A S O N					
	1953 thru 1958				1959 and 1960				Period 1953 thru 1960				H U N T I N G			S E A S O N		
	Popul:	Checked:	Index:	Rating:	Popul:	Checked:	Index:	Rating:	Popul:	Checked:	Index:	Rating:	Popul:	Checked:	Index:	Rating:	Popul:	Checked:
Mallard	: 22.58:	21.98 :	.97 :	1.00 ::	21.78:	26.11 :	1.19 :	1.00 ::	22.36:	23.40 :	1.04 :	1.00 ::	: 37.60:	40.30 :	1.07 :	1.00 ::	: 1.07:	: 1.00 :
Black	: 2.54:	1.01 :	.39 :	.40 ::	1.51:	1.09 :	.72 :	.64 ::	2.24:	1.04 :	.46 :	.44 ::	: 1.91:	2.28 :	1.19 :	1.07 ::	: 1.19:	: 1.07 :
Gadwall	: .65:	.27 :	.41 :	.42 ::	1.44:	1.75 :	1.21 :	1.01 ::	.88:	.78 :	.88 :	.85 ::	: 1.21:	1.33 :	1.09 :	1.01 ::	: 1.01:	: 1.01 :
Baldpate	: 17.27:	10.27 :	.59 :	.60 ::	40.38:	10.67 :	.26 :	.21 ::	24.11:	10.42 :	.43 :	.41 ::	: 14.58:	8.30 :	.56 :	.52 ::	: 1.58:	: 1.42 :
Pintail	: 10.85:	4.41 :	.40 :	.41 ::	7.39:	4.34 :	.58 :	.49 ::	9.83:	4.38 :	.44 :	.42 ::	: 5.68:	7.04 :	1.23 :	1.14 ::	: 1.23:	: 1.14 :
G.w. teal	: 3.14:	6.77 :	2.15 :	2.21 ::	4.11:	7.72 :	1.87 :	1.57 ::	3.43:	7.10 :	2.06 :	1.98 ::	: 1.56:	5.97 :	3.82 :	3.57 ::	: 3.57:	: 3.57 :
B.w. teal	: 27.87:	48.31 :	1.73 :	1.78 ::	9.35:	28.71 :	3.07 :	2.57 ::	22.42:	41.53 :	1.85 :	1.78 ::	: 8.39:	18.14 :	2.16 :	2.01 ::	: 2.01:	: 2.01 :
Shoveller	: .31:	.22 :	.70 :	.72 ::	.57:	.63 :	1.10 :	.92 ::	.39:	.36 :	.92 :	.88 ::	: .25:	.80 :	3.20 :	2.99 ::	: 2.99:	: 2.99 :
Wood Duck	: 11.34:	2.15 :	.18 :	.18 ::	9.16:	15.70 :	1.71 :	1.43 ::	10.70:	6.84 :	.63 :	.61 ::	: 4.13:	7.46 :	1.80 :	1.68 ::	: 1.68:	: 1.68 :
Redhead	: .11:	.38 :	3.45 :	3.55 ::	.46:	.36 :	.78 :	.65 ::	.21:	.37 :	1.76 :	1.69 ::	: .76:	.70 :	.92 :	.85 ::	: .85:	: .85 :
Ringneck	: 2.08:	3.60 :	1.73 :	1.78 ::	1.19:	2.30 :	1.93 :	1.62 ::	1.82:	3.15 :	1.73 :	1.66 ::	: 6.60:	3.13 :	.47 :	.44 ::	: .44:	: .44 :
Canvasback	: .14:	.09 :	.64 :	.65 ::	.29:	- :	- :	- ::	.18:	.06 :	.33 :	.32 ::	: 2.50:	.93 :	.37 :	.34 ::	: .34:	: .34 :
Scaup	: .74:	.39 :	.52 :	.53 ::	2.15:	.58 :	.26 :	.21 ::	1.16:	.46 :	.39 :	.38 ::	: 12.88:	3.02 :	.23 :	.21 ::	: .21:	: .21 :
Goldeneye	: t :	- :	- :	- ::	.03:	- :	- :	- ::	.01:	- :	- :	- ::	: .95:	.15 :	.15 :	.14 ::	: .14:	: .14 :
Bufflehead	: .01:	.02 :	2.00 :	2.06 ::	t :	.01 :	- :	- ::	.01:	.02 :	2.00 :	1.92 ::	: .12:	.11 :	.91 :	.85 ::	: .85:	: .85 :
Ruddy	: .07:	.09 :	1.28 :	1.31 ::	.11:	.02 :	.18 :	.15 ::	.08:	.07 :	.87 :	.84 ::	: .18:	.16 :	.88 :	.82 ::	: .82:	: .82 :
Mergansers	: .21:	.02 :	.09 :	.09 ::	.08:	.01 :	.12 :	.10 ::	.17:	.02 :	.11 :	.11 ::	: .69:	.10 :	.14 :	.13 ::	: .13:	: .13 :

\* Index: obtained by dividing percentage of checked kill by percentage in the population.

\*\* Rating: index obtained above was corrected to give mallards a rating of "1.00" (since percentage in population is almost the same as the percentage in the checked kill). Other ratings show comparison to mallards: i.e., if mallards have an arbitrary rating of 1.00, then green-winged teal with a rating of 3.57 has a vulnerability that is 3.57 times as great as mallards; blacks have a rating 1.07 times as great, etc.

Note: In 1953, the season opened on October 3; in 1954 on October 2; from 1955 thru 1958 on October 1; and in 1959 and 1960, on October 7. This short delay made a big difference in species composition in the population. Note, for instance, that baldpates increased from 17.27% of the opening population to 40.38%; while blue-wings dropped from 27.87% to 9.35%. Yet the apparent vulnerability of blue-wings was actually higher than with an earlier opening. Wood ducks, redheads, and canvasbacks have data complicated by whole or partial protection during some of the years of the study.

Table 25 - PERCENTAGE OF POPULATION IN CHECKED KILL

## Upper Mississippi Refuge

First week of the Hunting Season

Species	1953 thru 1958			1959 and 1960			Period 1953 thru 1960		
	Duck *	Checked	Per cent	Duck *	Checked	Per cent	Duck *	Checked	Per cent
	Population:	Kill	Harvested	Population:	Kill	Harvested	Population:	Kill	Harvested
Mallard	120,755	3,560	2.95	48,799	2,240	4.59	169,554	5,800	3.42
Black	13,595	164	1.21	3,388	93	2.74	16,983	257	1.51
Gadwall	3,470	43	1.24	3,222	150	4.65	6,692	193	2.88
Baldpate	92,351	1,667	1.81	90,463	915	1.01	182,814	2,582	1.41
Pintail	58,015	714	1.23	16,561	372	2.25	74,576	1,086	1.46
G.w. teal	16,770	1,097	6.77	9,202	662	7.19	25,972	1,759	6.77
B.w. teal	149,035	7,829	5.25	20,940	2,463	11.76	169,975	10,292	6.06
Shoveller	1,676	36	2.15	1,280	54	4.22	2,956	90	3.04
Wood duck	60,647	349	.57	20,526	1,347	6.56	81,173	1,696	2.09
Redhead	586	61	10.41	1,020	31	3.04	1,606	92	5.73
Ringneck	11,132	584	5.25	2,659	197	7.41	13,791	781	5.66
Canvasback	756	14	1.85	654	-	-	1,140	14	.99
Scaup	3,965	64	1.61	4,821	50	1.04	8,786	114	1.30
Goldeneye	2	-	-	54	-	-	56	-	-
Bufflehead	40	3	7.50	-	1	-	40	4	10.00
Ruddy	360	15	4.17	255	2	.78	615	17	2.76
Mergansers	1,125	3	.27	180	1	.56	1,305	4	.31
TOTAL	534,280	16,203	3.03	224,024	8,578	3.83	758,034	24,781	3.27

\* Actual census data to closest 100, but application of species composition percentages and averages for periods resulted in figures used.

Note: Harvest data on wood ducks, redheads and canvasbacks complicated by the fact that these species have had whole or partial protection during some of the years involved in this study, and the data shown here, which are based on averages, do not give a true picture of the situation.

Population and kill data shown by period above are the COMPOSITE figures obtained by adding information for all years in the period covered. They DO NOT indicate an annual population or kill, but are used to obtain the average kill percent for each of the periods.

Interesting, too, is the fact that with openings on October 1 to 3, redheads, although rare in the population, had a vulnerability rating of 3.45 compared with a rating of 0.65 in the period 1959-60 and to a rating of 0.88 for the entire period.

#### Crippling loss

Crippling loss data are available for the last 9 years of the period. It was found that for the entire area, the average crippling loss amounted to 15.37% of the total kill. (Cripples and bagged birds were added together, then the percentage of cripples to this total figure was determined. Thus, crippling loss as here shown indicates the percentage of the total removal of birds and not a relation between birds bagged and birds lost.)

Crippling loss varied greatly between the various areas checked, with the highest loss recorded at Keithsburg, followed by Upper Mississippi, Batchtown, Louisa, Calhoun, and Gardner. It is felt that perhaps the data from Keithsburg are not enough to mean much and should be viewed in this light.

Table 26 compares percentage crippling loss to other facets of the hunt.

Table 26 - Comparison of Crippling Loss and Hunter Success

Refuge Area	Percent Crippling Loss	Hours Hunted Per Duck Bagged	Av. Ducks Per Day
Upper Mississippi	20.94	3.94	1.23
Louisa	13.20	4.44	1.37
Keithsburg	25.27	5.72	.76
Gardner	6.34	7.35	.69
Batchtown	13.65	4.98	1.37
Calhoun	10.57	6.37	.90

If Keithsburg data are dropped from this table, it will be noted that as the crippling loss goes down the hours required per duck go up. This suggests the possibility that in an area where it is easier to bag a duck less time might be spent in searching for a downed bird than is the case where ducks are harder to get.

Although not indicated in this overall summary, records from the Upper Mississippi Refuge show that crippling losses are higher north of the Wisconsin River than south of there. This could well be influenced by cover conditions in the different portions of the refuge. As previously discussed, the best marsh development occurs

Table 27 - CRIPPLING LOSS BY AREA ON PERCENTAGE BASIS

For All Years in Which Data  
Are Available

Year	: 9 years	: 7 years	: 3 years	: 4 years	: 9 years	: 9 years	: 9 years
	: Upper Miss.	Louisa	: Keithsburg	Gardner	: Batchtown	Calhoun	ENTIRE
	: Refuge	Unit	: Unit	: Unit	: Unit	: Unit	AREA
1952	: 20.12	: -	: -	: -	: 15.63	: 5.55	: 18.12
1953	: 17.64	: -	: -	: -	: 23.90	: 14.49	: 23.35
1954	: 21.60	: 7.22	: -	: -	: 10.21	: 8.65	: 14.38*
1955	: 23.49	: 14.22	: 5.58	: -	: 11.73	: 11.82	: 14.79*
1956	: 22.14	: 20.29	: -	: -	: 12.95	: 9.60	: 13.60*
1957	: 18.75	: 4.67	: -	: 7.29	: 13.07	: 10.10	: 11.90**
1958	: 21.68	: 16.89	: -	: 4.41	: 12.50	: 10.30	: 13.89
1959	: 20.83	: 11.34	: 22.73	: 9.33	: 9.49	: 13.88	: 12.93
1960	: 22.15	: 17.46	: 47.50	: 4.35	: 13.43	: 10.81	: 15.45
AVERAGE	: 20.94	: 13.20	: 25.27	: 6.34	: 13.65	: 10.57	: 15.37

\* includes data from Middleton Island, Pool 24, in 1954, 1955, and 1956.

\*\* includes data from Oquawka Area, Pool 18, in 1957.

Note: The 1960 Waterfowl Status Report indicates that for the Mississippi Flyway, crippling loss in 1959 amounted to 18.42% (20.83% on Upper Mississippi and 12.93% on entire area); while in 1960, the Flyway loss was 20.43% (22.15% on Upper Mississippi and 15.45% on entire area).

north of the Wisconsin River, while it becomes progressively less further down river. Thus, crippling loss is probably also related to comparative density of cover in the areas being hunted, for heavy cover makes recovery of downed birds more difficult. In many areas of Mark Twain Refuge, blinds are situated where ducks knocked down fall into open water making recovery relatively easy.

A comparison of crippling loss by area and year is shown in table 27.

#### Estimated total kill by hunting

Over the past 7 years an average of 203,815 ducks have been killed each year on the areas checked. This figure includes birds brought to bag as well as those lost as cripples. The Upper Mississippi Refuge alone averages a kill of 153,475 ducks each year, including 121,050 bagged and 32,425 lost as cripples. Table 28 shows the 7-year average figure of birds killed by area checked.

Table 28 - Average Annual Kill

Area	Average annual bagged	Average annual crippling loss	AVERAGE ANNUAL TOTAL KILL
Upper Mississippi	121,050	32,425	153,475
Louisa	8,640	1,290	9,930
Keithsburg	2,895	980	3,875
Gardner	2,360	160	2,520
Batchtown	14,110	1,880	15,990
Calhoun	16,135	1,890	18,025
AVERAGE ANNUAL KILL	165,190	38,625	203,815

Total kill (bagged plus cripples) for each area checked, by year, is shown in table 29. (Table 30 shows average annual harvest, by species, for each area checked.)

#### Presunrise data

There has been much speculation as to the effect of this additional half-hour of shooting, both as to hunting success and

crippling losses which might be found during that period. Data on this subject were gathered in 1960.

Illinois did not permit presunrise shooting in 1960, so data from that State have been eliminated from all consideration.

In Minnesota, Wisconsin, and Iowa, a total of 5,657 hunters were checked in 1960. Of these, 2,002 hunted during the presunrise period, although none were checked that hunted in the presunrise period only. The 5,657 hunters took 7,488 ducks for a daily average of 1.32. The 2,002 presunrise hunters bagged 609 ducks, for a daily average of 0.30 ducks for each presunrise hunt. Thus, 22.73% of the daily average bag was taken in the presunrise half-hour. Based on total ducks checked (total ducks checked - 7,488, total checked in presunrise kill - 609), the presunrise kill amounted to only 8.13% of the checked bag.

Hunters checked in Minnesota, Wisconsin, and Iowa were afield 24,408 hours to bag the 7,488 ducks checked. It required 3.25 hours of hunting for each duck brought to bag; or there were 0.30 ducks bagged per hour. Consequently, if 0.30 ducks were bagged per hour, then for each half-hour there were 0.15 ducks bagged. Yet the presunrise hunters averaged 0.30 ducks each day they hunted that first half-hour for a success rate double that of any other 30-minute period of the day.

If there were 2,002 presunrise hunters, then it can be assumed that they hunted 1,001 hours in bagging their 609 ducks. On this basis, it required only 1.64 hours of hunting for each duck bagged compared to the overall average of 3.25 hours, and there were 0.60 ducks bagged per hour of hunting. So it appears that hunting success during that first half-hour of presunrise shooting was twice as good as for any other half-hour of the day.

What about crippling losses? Opponents of the presunrise shooting contend that crippling losses during that period of darkness are disproportionately high. What is really the case? Let us look at the data.

In Minnesota, Wisconsin, and Iowa, where presunrise shooting was permitted, a total of 5,598 hunters were questioned about losses. These hunters reported losing 2,183 ducks, for an average loss of 0.38 ducks per day. Of that number (5,598 hunters), a total of 1,921 were presunrise hunters. These 1,921 hunters lost only 129 ducks in presunrise shooting, for an average loss of 0.06 ducks per day. This was only 5.95% of the total loss, and it was accomplished by 35.76% of the total hunters checked (2,002 of the 5,598 checked, 129 cripples of the 2,183 reported).

Reducing the crippling loss to a loss per hour, we find that for all hunters there were 0.089 ducks lost per hour of hunting.

Table 29 - SUMMARY OF ESTIMATED TOTAL KILL  
 (Ducks Bagged plus Ducks Lost)

1954 through 1960

Year	7 years		7 years		5 years		4 years		7 years		7 years		ENTIRE	
	Upper Miss.		Louisa	Keithsburg	Gardner	Batchtown	Calhoun	ENTIRE	Refuge	Unit	Unit	Unit	Area	Area
1954	:	165,000	:	5,175	:	650	:	-	:	24,000	:	30,700	:	229,105*
1955	:	167,625	:	13,950	:	17,350	:	-	:	21,500	:	26,350	:	249,175**
1956	:	188,250	:	10,250	:	800	:	-	:	18,400	:	15,350	:	236,830***
1957	:	207,700	:	14,005	:	-	:	3,850	:	18,360	:	16,830	:	262,640****
1958	:	157,450	:	4,600	:	-	:	2,380	:	7,280	:	15,520	:	187,230
1959	:	82,025	:	10,765	:	330	:	1,330	:	11,470	:	6,765	:	112,685
1960	:	106,270	:	10,785	:	240	:	2,525	:	10,920	:	14,650	:	145,390
AVERAGE	:	153,475	:	9,930	:	3,875	:	2,520	:	15,990	:	18,025	:	203,815

\* includes 3,580 killed in Pool 24

\*\* includes 2,400 killed in Pool 24

\*\*\* includes 3,780 killed in Pool 24

\*\*\*\* includes 1,895 killed at Oquawka, Pool 18

Table 30 - AVERAGE ANNUAL KILL BY SPECIES

Species	Upper Miss.		Louisa		Keithsburg		Gardner		Batchtown		Calhoun		ENTIRE AREA	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Mallard	61,850	40.30	7,730	83.08	3,700	95.28	2,210	87.73	13,245	82.79	13,200	73.25	101,935	49.77
Black	3,500	2.28	38	.39	15	.40	5	.23	60	.36	135	.75	3,753	1.86
Gadwall	2,040	1.33	80	.85	-	-	20	.85	50	.31	235	1.29	2,425	1.19
Baldpate	12,750	8.30	110	1.20	30	.82	40	1.48	130	.83	575	3.18	13,635	6.76
Pintail	10,800	7.04	225	2.74	50	1.30	25	1.05	1,340	8.40	880	4.87	13,320	6.62
G.w. teal	9,160	5.97	190	2.04	25	.67	65	2.58	290	1.80	900	5.01	10,630	5.28
B.w. teal	27,850	18.14	190	2.05	10	.30	16	.67	215	1.35	590	3.28	28,871	14.30
Shoveller	1,225	.80	35	.36	15	.41	8	.30	40	.27	255	1.41	1,578	.78
Wood duck	11,450	7.46	390	4.15	30	.82	20	.79	54	.34	400	2.22	12,344	6.12
Redhead	1,075	.70	15	.18	-	-	6	.25	54	.34	65	.36	1,215	.61
Ringneck	4,800	3.13	30	.30	-	-	12	.50	170	1.06	100	.56	5,112	2.54
Canvasback	1,425	.93	25	.28	-	-	2	.10	55	.35	50	.28	1,557	.77
Scaup	4,635	3.02	210	2.25	-	-	80	3.07	255	1.60	540	3.00	5,720	2.86
Goldeneye	230	.15	6	.07	-	-	1	.05	6	.04	25	.15	268	.13
Bufflehead	170	.11	1	.01	-	-	4	.16	10	.06	15	.07	200	.10
Ruddy	245	.16	2	.02	-	-	1	.02	14	.09	30	.17	292	.15
Mergansers	150	.10	3	.03	-	-	4	.15	2	.01	20	.11	179	.09
Other ducks	120	.08	-	-	-	-	1	.02	-	-	10	.04	131	.07

Note: The kill for the ENTIRE AREA includes areas such as Oquawka, Middleton Island, etc., from which data are available during some years.

This table shows that mallards comprise 49.77% of the total kill; and the table on page 36 shows the percentage of total checked kill as 62.90%. The difference in percentages results from the fact that while the table on page 36 shows percentage of actual CHECKED KILL, this table shows a computed kill; and the total column on estimated numbers shows accumulated data from calculated kill by individual areas. The percentage was then worked out AFTER the total kill figure was obtained. This accounts for the difference. Over half of the total computed kill was found on the Upper Mississippi Refuge.

Yet in the presunrise hunting where 1,001 hours of hunting accounted for a loss of 129 ducks, the loss was 0.128 ducks per hour, representing a loss 43.82% greater per hour than for the average hour of the day.

Although the hourly crippling loss was higher in the presunrise period than for other times of the day, the rate of crippling was actually less. Presunrise hunters reported losing 129 ducks while bagging 609 so that the percentage loss during that period was 17.48% compared with the overall loss of 20.94%. While presunrise hunters have a crippling loss per hour that is nearly 44% greater than the overall loss per hour, they also bag twice as many ducks while doing so, with the result that the rate of crippling is actually less in the presunrise period.

In 1953 we were concerned over the effect of the last hour of hunting when an additional period of time was provided at the close of each day. In connection with consideration of the effect of the extra shooting time in the evening, we conducted studies here to sample the period of the day when most hunting was done as well as to sample the kill in the last hour of the day.

At that time, of the 4,166 hunters contacted, 235 hunted during the last hour. These hunters took only 5.64% of the total checked kill (which was recorded separately and not included in the afternoon checks since that would have resulted in duplication).

At that time we were averaging 11 hours of potential hunting each day, as shooting started 1/2 hour before sunrise and continued to sunset. If this provided 11 hours of shooting, then one could assume that at least 9% of the kill could be taken each hour; yet the last hour hunters took only about 45% of the hourly potential.

Figures obtained at that time unfortunately did not separate the presunrise data from the rest of the morning hunting. However, it was found that of the total kill, 34.45% occurred among hunters who shot only in the afternoon, 48.82% among hunters out only in the afternoon (not including the last hour), 11.09% among hunters who were out all day, and only 5.64% of the kill occurred the last hour.

#### EVALUATION OF HUNTING PRESSURE

##### Distribution of kill among hunters checked

One of the most interesting facets of the study has been a breakdown of data to show the percentage of hunters who successfully took a limit, those who took less than limits, and those who failed to bag ducks on the day they were checked.

Throughout most of the study the maximum limit has been 4 ducks per day with the following variations:

- 1946 - maximum limit 7 ducks.  
1955 - 5 ducks in Minnesota, 4 in other three States.  
1959 - 4 ducks in Minnesota and Illinois, 3 ducks in Wisconsin and Iowa.  
1960 - 4 ducks in Illinois, 3 ducks in Minnesota, Wisconsin and Iowa.

In 1946 it was found that hunters fell into the following groups:

<u>Number of ducks</u>	<u>Percentage of hunters</u>
7 )	5.60 )
6 )	2.40 )
5 ) Composite	2.70 ) 14.70
4 )	4.00 )
3	8.00
2	11.30
1	22.00
0	44.00

In 1955 during the 5-duck limit in Minnesota, it was found that only 3.64% of the hunters checked took the additional duck, while combining those with 4 and 5 ducks for the entire area showed 10.61% of the hunters fell into this combined grouping.

Over the entire period of study, it was found that hunters fell into groups as follows:

	<u>Percent</u>
4 or more ducks	10.44
3 ducks	7.28
2 ducks	12.31
1 duck	24.66
0 ducks	45.31

These data are summarized by area and year in table 34.

Refining the data further, it was found that the following groupings could be made:

Table 31 - Hunter Success

## Percent of Hunters

Ducks in Bag	Upper Mississippi	Mark Twain	ENTIRE AREA
4 or more ducks	9.47	10.85	10.44
3 or more ducks	19.14	17.12	17.72
3 ducks	9.67	6.57	7.28
2 or more ducks	35.57	28.54	30.03
1 and 2 ducks	40.62	35.43	36.97
2 ducks	14.43	11.42	12.31
1 duck	26.19	24.01	24.66
0 ducks	40.24	47.45	45.31

In other words, over the entire period of the study only 17.72% of the 251,876 hunters checked were successful in taking three or more ducks on the days they were checked, only 30.03% were successful in taking two or more, and 24.66% of the hunters managed to bag a single duck. There were also 45.31% of the hunters who were completely unsuccessful on the days they were checked.

It is interesting to speculate as to the importance of the hunters in the various success groups so far as total harvest is concerned. While only 10.44% of the hunters were successful in bagging four or more ducks, this group accounted for 37.20% of the total kill. Although this group accounted for a high percentage of the kill, it is interesting to note that the additional birds in the bag resulted in a kill of only 9.54% more ducks than would have occurred had the limit never exceeded three ducks per day. (See tables 36, 37 and 38.)

Table 32 - PERCENTAGE OF HUNTERS TAKING 4 OR MORE BIRDS, 3, 2, 1 AND 0 BIRDS

(1946 data broken down only for entire area; no 1948 data on any area)

Year	Upper Mississippi Refuge					Louisa Unit					Keithsburg Unit					Gardner Unit					
	4	3	2	1	0	4	3	2	1	0	4	3	2	1	0	4	3	2	1	0	
1947	14.50:	8.50:	14.00:	24.00:	39.00:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1949	16.74:	14.49:	17.89:	25.81:	25.07:	5.95:	8.22:	22.66:	35.98:	27.19:	-	-	-	-	-	-	-	-	-	-	
1950	5.97:	5.58:	11.63:	29.75:	47.07:	13.29:	1.33:	6.64:	26.58:	52.17:	-	-	-	-	-	-	-	-	-	-	
1951	19.29:	12.13:	18.75:	22.75:	27.08:	29.59:	15.56:	13.95:	17.00:	23.81:	5.00:	10.00:	15.00:	38.33:	31.67:	-	-	-	-	-	
1952	11.30:	9.66:	15.66:	25.73:	37.65:	9.84:	7.17:	19.47:	31.25:	32.17:	-	-	-	-	-	-	-	-	-	-	
1953	10.05:	9.25:	15.39:	27.28:	38.03:	8.79:	4.12:	9.61:	34.62:	42.86:	8.75:	2.50:	26.25:	35.00:	27.50:	-	-	-	-	-	
1954	7.92:	6.50:	11.59:	26.40:	47.59:	23.20:	5.13:	9.24:	27.52:	34.91:	3.85:	.96:	14.42:	35.58:	45.19:	-	-	-	-	-	
1955	8.55:	7.71:	14.61:	27.30:	41.83:	26.00:	10.22:	13.33:	20.89:	29.56:	29.73:	21.62:	24.33:	21.62:	2.70:	-	-	-	-	-	
1956	10.13:	6.49:	13.76:	24.64:	44.98:	10.86:	10.41:	30.92:	28.58:	19.23:	-	-	4.82:	7.23:	27.71:	60.24:	-	-	-	-	-
1957	14.09:	7.87:	13.47:	22.73:	41.84:	36.12:	18.90:	14.60:	14.68:	15.70:	-	-	-	-	-	-	7.30:	6.39:	9.68:	21.63:	55.00:
1958	9.68:	6.68:	13.21:	26.35:	44.08:	13.05:	7.52:	12.61:	23.12:	43.70:	-	-	-	-	-	-	4.86:	4.19:	7.00:	18.53:	65.42:
1959	.60:	16.70:	17.16:	28.17:	37.37:	-	-	-	-	-	-	-	-	-	-	-	4.97:	4.46:	7.13:	21.34:	62.10:
1960	2.81:	19.37:	16.40:	28.32:	33.10:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AV.	9.47:	9.67:	14.43:	26.19:	40.24:	19.16:	10.49:	17.28:	24.45:	28.62:	6.87:	5.77:	16.48:	32.69:	38.19:	5.96:	5.21:	8.21:	20.41:	60.21:	..

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Year	Batchtown Unit					Calhoun Unit					ENTIRE AREA					1946: limit, 7 ducks; this 14.70% includes all with 4 or more
	4	3	2	1	0	4	3	2	1	0	4	3	2	1	0	
1946	-	-	-	-	-	-	-	-	-	-	14.70:	8.00:	11.30:	22.00:	44.00:	..
1947	30.50:	10.70:	14.03:	25.88:	18.87:	12.09:	8.79:	14.91:	26.37:	37.85:	14.50:	8.50:	14.00:	24.00:	39.00:	..
1949	18.51:	11.22:	15.27:	24.46:	30.54:	16.54:	7.30:	15.93:	31.00:	29.20:	16.52:	11.64:	17.08:	27.37:	27.39:	1955: 5 ducks in Minn.; 4 in other States
1950	17.46:	11.50:	14.02:	15.72:	41.30:	8.14:	4.64:	9.68:	31.17:	46.37:	8.85:	6.45:	11.60:	27.14:	45.26:	..
1951	24.49:	8.60:	11.40:	26.54:	28.97:	9.46:	7.68:	13.57:	27.57:	41.72:	16.71:	10.43:	15.73:	24.53:	32.60:	..
1952	10.82:	6.04:	13.96:	38.88:	30.30:	9.07:	5.78:	10.50:	28.20:	46.45:	10.49:	7.66:	13.96:	29.46:	38.43:	..
1953	17.81:	10.81:	14.68:	21.17:	35.53:	2.68:	3.22:	7.66:	23.33:	63.11:	8.98:	6.96:	11.88:	24.22:	47.96:	1959: Minn. & Ill. chose 4-bird limit and 40 days; Iowa and Wisconsin chose 3 birds and 50 days
1954	18.96:	10.24:	16.65:	27.34:	26.81:	7.12:	4.82:	11.82:	28.31:	47.93:	11.36:	6.83:	12.92:	27.18:	41.71:	..
1955	22.16:	7.13:	13.23:	21.74:	35.74:	9.00:	5.82:	9.98:	23.32:	51.88:	13.05:	6.87:	12.22:	23.92:	43.94:	..
1956	13.63:	6.67:	11.39:	23.28:	45.03:	8.20:	4.70:	9.12:	20.92:	57.06:	10.61:	6.05:	11.96:	22.80:	48.58:	..
1957	14.21:	7.96:	13.33:	25.34:	39.16:	6.83:	5.58:	10.13:	24.27:	53.19:	10.72:	7.06:	11.60:	23.72:	46.90:	..
1958	7.10:	4.29:	11.27:	26.62:	50.72:	8.48:	4.36:	9.29:	21.90:	55.97:	8.30:	5.02:	10.45:	23.45:	52.78:	..
1959	17.86:	7.75:	13.30:	22.25:	38.84:	3.70:	3.07:	8.46:	21.51:	63.26:	7.35:	7.93:	11.96:	23.35:	49.41:	1960: Minn., Wisconsin and Iowa chose 3 birds and 50 days; Ill. chose 4 birds and 40 days
1960	11.68:	7.25:	13.80:	27.64:	39.63:	9.22:	6.08:	11.12:	24.46:	49.12:	7.93:	9.29:	12.72:	25.55:	44.51:	..
AV.	15.97:	7.82:	13.32:	24.68:	38.21:	7.85:	5.24:	10.20:	23.93:	52.78:	10.44:	7.28:	12.31:	24.66:	45.31:	..

Table 33 - Distribution of Kill Among Hunter Success Groups

Percent of Total Harvest

Ducks in bag	Upper Mississippi	Mark Twain	ENTIRE AREA
4 or more ducks	31.62	39.85	37.20
3 or more ducks	55.22	57.08	56.48
3 ducks	23.60	17.23	19.28
2 or more ducks	78.70	78.00	78.22
1 and 2 ducks	44.78	42.92	43.52
2 ducks	23.48	20.92	21.74
1 duck	21.30	22.00	21.78

While these data obtain for the hunting lands along the Mississippi River under hunting conditions that exist here, they may not hold true in other parts of the country or under different conditions of hunting. Where extensive field shooting is done, an entirely different situation may exist.

For hunting such as is found along the Mississippi River, it is extremely interesting to note that in the higher success groups (those hunters taking 3 or 4 birds per day) a total of 17.72% of the hunters are found, and that this 17.72% of the hunters account for 56.48% of the total harvest. The lower success groups (those with 1 or 2 ducks per day) make up 40.62% of the total hunters checked, and accounted for only 43.52% of the total kill.

Let us now examine the data in terms of possible harvest, had different bag limits been in effect. (See tables 36, 37, and 38 on pages 54, 55, and 56.)

In other words, with different bag limits (assuming hunting pressure and other conditions remained unchanged) the kill might be reduced as follows:

Table 34 - DISTRIBUTION OF KILL AMONG HUNTERS

1946 thru 1960

No.Ducks In Bag	U P P E R   M I S S   R E F U G E				M A R K   T W A I N   R E F U G E				E N T I R E   A R E A				
	Hunters Checked		Total Ducks:Percent		Hunters Checked		Total Ducks:Percent		Hunters Checked		Total Ducks:Percent		
	Number	%	Checked	of Kill	Number	%	Checked	of Kill	Number	%	Checked	of Kill	
52	0	27,949	40.24	0	0.00	78,240	47.45	0	0.00	106,189	45.31	0	0.00
	1	18,191	26.19	18,191	21.30	39,592	24.01	39,592	22.00	57,783	24.66	57,783	21.78
	2	10,025	14.43	20,050	23.48	18,824	11.42	37,648	20.92	28,849	12.31	57,698	21.74
	3	6,716	9.67	20,148	23.60	10,337	6.27	31,011	17.23	17,053	7.28	51,159	19.28
	4	6,160	8.87	24,640	28.85	17,823	10.81	71,292	39.62	23,983	10.23	95,932	36.15
	5	265	.38	1,325	1.56	16	.01	80	.04	281	.12	1,405	.53
	6	47	.07	276	.32	14	.01	84	.05	60	.03	360	.14
	7	108	.15	756	.89	36	.02	252	.14	144	.06	1,008	.38
	TOTALS	69,461	100.00	85,386	100.00	164,882	100.00	179,959	100.00	234,342	100.00	265,345	100.00
Hunters with 4 or: more ducks		6,580	9.47	26,997	31.62	17,889	10.85	71,708	39.85	24,468	10.44	98,705	37.20

Table 35 - DISTRIBUTION OF KILL AMONG HUNTER SUCCESS GROUPS  
 Upper Mississippi and Mark Twain Refuges  
 1946 thru 1960 Seasons

Hunter Group Taking	Upper Miss. Refuge		Mark Twain Refuge		ENTIRE AREA	
	Percent of Hunters in Group	Percent of TOTAL Kill	Percent of Hunters in Group	Percent of TOTAL Kill	Percent of Hunters in Group	Percent of TOTAL Kill
4 or more	9.47	31.62	10.85	39.85	10.44	37.20
3	9.67	23.60	6.57	17.23	7.28	19.28
2	14.43	23.48	11.42	20.92	12.31	21.74
1	26.19	21.30	24.01	22.00	24.66	21.78
0 ducks	40.24	0.00	47.45	0.00	45.31	0.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00
3 or more	19.14	55.22	17.12	57.08	17.72	56.48
2 or more	35.57	78.70	28.54	78.00	30.03	78.22
1 and 2	40.62	44.78	35.43	42.92	36.97	43.52

Table 36 - DISTRIBUTION OF KILL AMONG HUNTERS

Upper Mississippi Refuge

1946 thru 1960

54

Number Ducks In Bag	: Number Hunters Checked	: Total Checked	: Kill over 3 ducks	: Kill if limit were 3	: Kill over 2 ducks	: Kill if limit were 2	: Kill over 1 duck	: Kill if limit were 1
0	: 27,949	: 0	: 0	: 0	: 0	: 0	: 0	: 0
1	: 18,191	: 18,191	: 0	: 18,191	: 0	: 18,191	: 0	: 18,191
2	: 10,025	: 20,050	: 0	: 20,050	: 0	: 20,050	: 10,025	: 10,025
3	: 6,716	: 20,148	: 0	: 20,148	: 6,716	: 13,432	: 13,432	: 6,716
4	: 6,160	: 24,640	: 6,160	: 18,480	: 12,320	: 12,320	: 19,480	: 6,160
5	: 265	: 1,325	: 530	: 795	: 795	: 530	: 1,060	: 265
6	: 46	: 276	: 138	: 138	: 184	: 92	: 230	: 46
7	: 108	: 756	: 432	: 324	: 540	: 216	: 648	: 108
TOTALS	: 69,460	: 85,386	: 7,260	: 78,126	: 20,555	: 64,831	: 44,875	: 41,511
Percent of Checked Kill Represented			: 8.50	: 91.50	: 24.07	: 75.93	: 51.38	: 48.62

Table 37 - DISTRIBUTION OF KILL AMONG HUNTERS

Mark Twain Refuge

1946 thru 1960

Number Ducks In Bag	Number Hunters Checked	Total Kill	Kill over 3 ducks	Kill if limit 3 ducks	Kill over 2 ducks	Kill if limit 2 ducks	Kill over 1 duck	Kill if limit 1 duck	Kill
0	78,240	0	0	0	0	0	0	0	0
1	39,592	39,592	0	39,592	0	39,592	0	39,592	0
2	18,824	37,648	0	37,648	0	37,648	0	37,648	0
3	10,337	31,011	0	31,011	10,337	20,674	20,674	20,674	10,337
4	17,823	71,292	17,823	53,469	35,646	35,646	53,469	53,469	17,823
5	16	80	32	48	48	32	64	16	16
6	14	84	42	42	56	28	70	14	14
7	36	252	144	108	180	72	216	36	36
TOTALS	164,882	179,959	18,041	161,918	46,267	133,692	93,317	86,642	0
Percent of Checked Kill Represented			10.02	89.97	25.71	74.29	51.85	48.15	0

Table 38 - DISTRIBUTION OF KILL AMONG HUNTERS

Upper Mississippi and Mark Twain Refuges Combined

1946 thru 1960

65

Number Ducks In Bag	Number Hunters Checked	Total Checked Kill	Kill over 3 ducks	Kill if limit were 3	Kill over 2 ducks	Kill if limit were 2	Kill over 1 duck	Kill if limit were 1
0	106,189	0	0	0	0	0	0	0
1	57,783	57,783	0	57,783	0	57,783	0	57,783
2	28,849	57,698	0	57,698	0	57,698	28,849	28,849
3	17,053	51,159	0	51,159	17,053	34,106	34,106	17,053
4	23,983	95,932	23,983	71,949	47,966	47,966	71,949	23,983
5	281	1,405	562	843	843	562	1,124	281
6	60	360	180	180	240	120	300	60
7	144	1,008	576	432	720	288	864	144
TOTALS	234,342	265,345	25,301	240,044	66,822	198,523	137,192	128,153
Percent of Checked Kill Represented			9.54	90.46	25.18	74.82	51.70	48.30

Percent of Kill That Might Have Been Saved With  
Different Sized Bag Limits  
(Compared to limit of 4)

<u>Bag limit</u>	<u>Percent reduction in kill</u>
3	9.54
2	25.18
1	51.70

If, under conditions found in the area under study, a bag limit of four ducks will affect only 10.24% of the total hunters and increase the kill only 9.54% (compared to a 3-bird limit), perhaps a 4-bird limit is relatively unimportant since the total kill under conditions along the Mississippi River will be increased only nominally. One could also argue that if a 4-bird limit would affect such a small percentage of the hunters, there is no real justification for placing the resource in jeopardy under present populations levels.

#### CONCLUSIONS

1. The type of public hunting described furnishes a great deal of hunting opportunity to many hunters. On the Upper Mississippi Refuge the public hunting area is administered by the Fish and Wildlife Service, accounting for one of the largest Service-controlled waterfowl-hunting areas. Although about 15% of the ducks using the refuge fall to hunters' guns, the area still affords sanctuary to large numbers of ducks. Where refuges are established along migration routes, perhaps one of their major functions is to improve hunting distribution while at the same time furnishing protection to ducks that would otherwise be "burned out" of an area.

2. The type of bag-check system described furnishes much valuable information about the effectiveness of a refuge where public hunting is permitted, as well as giving some idea of the value of inviolate sanctuaries in furnishing hunting to surrounding areas.

3. The study indicates that in the Northern States, opening dates are important in species management. With blue-winged teal, for example, an opening as early as October 1 will result in a high harvest of blue-wings, while a delay of as little as 1 week will markedly reduce the kill of these birds. Should it be determined that blue-wings are being underharvested, perhaps an opening even earlier than October 1 should be considered. With an

October 1 opening in Minnesota and Wisconsin, as much as 75% of the opening-day kill is made up of blue-wings. When the season opened as late as October 7, the opening-day kill dropped to about 25% blue-wings. These early season birds move out with the first cold snap, usually the first week in October; and in late October when the Illinois season opens, they are mostly gone from the upper river and have thinned out even on Mark Twain Refuge to the south.

4. A late opening day will also result in reduced wood duck kills since these birds, too, are killed in significant numbers only early in the season and are seldom checked in the bag after October 10.

5. Since the presunrise success rate is higher than any other period of the day, the elimination of this period of hunting will tend to reduce total kill.

6. Since only 17.72% of the hunters in this area have taken three or more ducks on the day they were checked, it appears that liberalization of bag limits will affect only about a fifth of the hunters. This group, however, takes 56.48% of the total harvest. Only 10.44% of the hunters take four or more ducks, accounting for 37.20% of the total kill. It was found that 36.97% of the hunters checked fell into the 1- and 2-bird category, accounting for 43.52% of the total kill. Thus, it appears that an effective method of reducing total kill is by reducing bag limits which would not affect more than a fifth of the hunters in this area. It is postulated that dropping the limit from 4 to 3 ducks would have saved 9.54% of the total kill recorded along the river in the past 15 years, while affecting only 10.44% of the hunters.

#### SUMMARY

1. Bag-check data have been obtained on the Upper Mississippi River Wildlife and Fish Refuge since 1946 when they were initiated in conjunction with activities of the Technical Game Committee of the Upper Mississippi River Conservation Committee, on Calhoun Unit of Mark Twain Refuge since the same year, and from other units of Mark Twain Refuge as they came under management.

2. Waterfowl utilization and bag-check information have been obtained over 284 miles of the Upper Mississippi Refuge involving 194,000 acres, and an additional 250 miles of Mark Twain Refuge between Rock Island, Ill., and Alton, Ill., involving 67,695 acres.

3. In the area under study, 205,292 acres (78.45%) are open to public hunting and 56,403 acres (21.55%) are in sanctuary areas closed to hunting. On the Upper Mississippi Refuge 153,225 acres (79%) are open to public hunting and 40,775 acres (21%) are closed. On Mark Twain Refuge no hunting is permitted on the managed refuge units. Hunting is carried out on lands turned over to the various States and is permitted on the peripheries of the refuge units.

4. Mass migration flights occurred in 4 years out of the 15 (in 1947, 1948, 1955, and 1956). In the other 11 years there were steady dribblings of birds with no mass movements.

5. Over the 1953-60 period, waterfowl numbers were high on all areas during the period of the hunting season. An average of 29,965,010 days of duck use occurs on the area under study during the period of the hunting season (October 1-December 27), amounting to 81.8% of total fall use. The average weekly population occurring during the hunting season is 420,150 ducks, and the average peak population is 767,140 ducks (the highest peak recorded was 1,379,965 in 1953).

6. On Mark Twain Refuge duck-day use showed a marked decline in 1957, the year that the Missouri River reservoirs in the Dakotas started holding ducks, and has decreased since that time. Many of the ducks using Mark Twain move in from the northwest. On the Upper Mississippi Refuge the northwest movement is important only on the extreme south end, and populations did not show the dip in 1957 which was so apparent on Mark Twain.

7. Mallards, comprising 72.40% of the total fall flight, also account for 62.90% of the checked kill. On the Upper Mississippi Refuge, mallards account for only 37.60% of the total flight and 40.30% of the checked kill.

8. The average number of days of hunting each year on the Upper Mississippi Refuge is 102,920 (highest was 129,845 days in 1957) and the entire area averages 135,785 days of hunting (highest was 178,285 days in 1954).

9. During the 15-year period, bag-check data have been obtained from 251,876 hunters, having 283,763 ducks, for a daily average of 1.12 ducks per hunter-day. The highest average recorded for the entire area was 1.64 ducks per day in 1949, while the lowest overall average was 0.93 ducks per day in 1958.

10. The average hunt lasts 5.26 hours on the area under study, with the lowest average (4.64 hours) being recorded on the Upper Mississippi Refuge and the highest (6.37 hours) near the Calhoun Unit of Mark Twain Refuge.

11. On the Upper Mississippi Refuge, it required an average of 3.94 hours of hunting per duck bagged, while near the Gardner Unit of Mark Twain, it required 7.35 hours of hunting per duck. For the entire area, an average of 4.95 hours of hunting was required per duck bagged.

12. Mallards comprised the bulk of the kill over the entire area checked, ranging from 40.30% of the checked kill on the Upper Mississippi Refuge to 95.21% near the Louisa Unit of Mark Twain. For the entire area mallards accounted for 62.90% of the checked kill. Most of the blue-winged teal and wood duck harvest occurs during the first few weeks of the season; other species are harvested quite uniformly throughout the season, except that goldeneyes and scoters show up in the late part of the season.

13. A table of vulnerability was worked out for hunting conditions found in the area under study. Mallards, which were present in nearly the same percentage in the population and the checked kill, were assigned a rating of 1, and all other species were compared to this.

14. Crippling loss varied from 25.27% near Keithsburg Unit to a loss of 6.34% near Gardner Unit. The Upper Mississippi Refuge averaged a loss of 20.94%. The overall average was 15.37%. There was some correlation between the hours required per duck and the crippling loss; that is, where more time was required per duck, the crippling loss was lower, and where fewer hours were required per duck bagged, the crippling loss was higher. This may reflect the effort expended to recover birds knocked down, the number of opportunities for crippling, or the type of hunting cover.

15. The average annual kill from the area checked was 203,815 ducks (including crippling loss). The average actual bag was 165,190 ducks per year, and the average crippling loss was 38,625 ducks per year.

16. Although mallards constitute the bulk of the kill with an average kill in excess of 100,000 birds, there are 19 species of ducks commonly harvested along the Mississippi River.

17. Presunrise hunting was twice as effective per unit of time as was later shooting. Presunrise crippling was 43% higher per unit of time than in later shooting, but the rate of crippling was actually less because of the greater number of birds taken during the presunrise period.

18. Of the 251,876 hunters checked over the 15-year period, 45.31% failed to bag game on the day they were checked, 10.44% succeeded in taking four or more ducks (depending on limit), 17.72% succeeded in taking three or more ducks, 30.03% took two or more, and 24.66% took a single duck.

19. Those hunters taking four or more ducks accounted for 37.20% of the total harvest, those taking three or more accounted for 56.48% of the total harvest, and those taking one or two ducks (36.97% of the hunters) took 43.52% of the total harvest.

20. It was concluded that the harvest was increased only 9.54% over the 15-year period because of the four or more ducks permitted compared with what would have occurred with a 3-bird limit. Thus, the 10.44% of the hunters in this group took only 9.54% more ducks than had the limit been three birds.

21. If all other facets of the hunt, such as number of hunters and methods of hunting, remained unchanged, then had the limit never exceeded two birds, the kill could have been reduced 25.18% below the actual harvest; and had the limit been one duck, the kill would have been 51.70% less than actually occurred.

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